5th Boehringer Ingelheim Expert Forum on

Farm Animal
well-being

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Boehringer
Ingelheim

Welcome,

We are very pleased to invite you to the 5th Boehringer Ingelheim Expert Forum on Farm Animal Well-Being.

This year, our forum leaves Spain to take place in Lisbon, capital city of Portugal and one of the oldest cities in the world.

We, at Boehringer Ingelheim are much honored to organise this event for now the fifth time. The success of this initiative demonstrates, if deemed necessary, that the veterinary profession is highly interested by Farm Animal Well-Being –related topics. We must acknowledge that also high is the need for more information and appropriate continuing professional education.

Hence, our Expert Forum on Farm Animal Well-Being has become a recognised discussion platform which facilitates communication and transfer of knowledge between veterinarians and animal scientists, as well as a highly commended place to mingle and socialise.

Among the main topics to be adressed this year, we have identified both voluntary and unvoluntary culling of farm animals as being worth a discussion through the following questions:

How may welfare of farm animals at culling (slaughter or killing) be addressed?

Is culling of unproductive animals ethically justified?

When shall a farmer maintain and treat, or cull a cow?

The second part of the forum will be dedicated to pain associated with parturition:

How can we predict, identify, and assess health problems in the transition cow through behavioural changes?

What are the practical methods to reduce pain associated with obstetrical procedures?

And finally, *may NSAIDs be safely and effectively used to mitigate postoperative pain and discomfort following non-elective caesarean section in cattle?*

We are very much looking forward to welcoming you to Lisbon for a constructive and fruitful exchange.

Boehringer Ingelheim Animal Health

5[TH] Boehringer Ingelheim Expert Forum on

Farm Animal Well-Being

Content

Is culling of farm animals a welfare issue?

How painful is parturition to farm animals?

Dr. Suzanne T. Millman, B.Sc. (Agr), Ph.D.

Dr. Suzanne Millman joined the faculty of the Iowa State University College of Veterinary Medicine in 2008, as Associate Professor of Animal Welfare in the Veterinary Diagnostic and Production Animal Medicine and the Biomedical Sciences departments. Dr. Millman's appointment consists of 50 % research, 30 % teaching and 20 % professional practice and outreach. Prior to coming to ISU, Millman was faculty at the Ontario Veterinary College, where she continues to hold an adjunct appointment.

Millman's research interests include animal welfare assessment, pain and sickness behaviour, and practical solutions to address animal welfare in production environments, particularly in relation to compromised cattle, swine and poultry. Dr. Millman coordinates animal welfare instruction within the DVM curriculum and serves as co-Chair for the AVMA Model Animal Welfare Curriculum Working Group.

Millman serves as a resource to the livestock and poultry industries by delivering educational materials that support development of evidence based best practices in animal welfare throughout the food supply chain. Millman serves as Section Editor (Farm Animals) for the Journal of Applied Animal Welfare Science, and chairs the Iowa VMA Animal Welfare Committee and the Iowa Animal Cruelty Response Task Force.

Millman received her B.Sc. (Agr) and Ph.D. in applied ethology from the Department of Animal & Poultry Science, University of Guelph, Canada. Her thesis dissertation was *An investigation into extreme aggressiveness of broiler breeder males.*

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Culling of farm animals and welfare implications

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Case study - Heifer X

A 10 month-old beef heifer was admitted to the veterinary hospital at Iowa State University for a non-weight bearing injury, associated with a fall on the ice three days prior. Her vital parameters were within normal limits, and there was extensive soft tissue swelling at the level of her right femur as well as increased fluid at her right stifle joint. General anesthesia was performed to facilitate radiology, which confirmed a midshaft, complete, displaced spiral fracture of the femur. Surgical repair of the fracture was performed using special orthopedic plates, and the heifer recovered uneventfully from anesthesia. Antimicrobial and nonsteroidal anti-inflammatory therapies were administered to prevent infection and to decrease pain and inflammation. Heifer X was hospitalized for the following two weeks and continued to receive pain medications. Blood work on Day +12 revealed no significant abnormalities, but abnormal position of the leg and excessive swelling were observed on Day +13. Radiographs indicated a fracture of femur just below the implanted plates. Poor prognosis was determined based on the nature of the fracture, and euthanasia was recommended. Captive bolt euthanasia was performed.

(photograph provided by Dr. Jennifer Schleining)

Figure 1. Heifer X recovering from surgery at the Lloyd Veterinary Medical Center, Iowa State University.

Animal welfare and the decision making tree for Heifer X

I could present the case of Heifer X as one of disappointment or failure. However, in my opinion this is an example of an effective decision making tree at work addressing the needs and qualities of the heifer, her injury, her owner and her veterinary team. To assess the implications for animal welfare in this decision, further details are needed.

The most important criteria for assessing animal welfare are the measures we can make directly on the heifer. Heifer X was only 10 months of age, and this impacts her potential for her to recover from the injury and longevity. The nature of her fracture was consistent with repair, and importantly her temperament was conducive to convalescence and intensive handling. Heifer X had been trained and exhibited as a show calf; she was extremely calm and easy to restrain and handle. She appeared to enjoy human-animal interactions, and was familiar with transportation, isolation and confinement. Hence, she was able to cope with transport to and housing within the veterinary hospital without complications of fear-related panic or aggression. Upon presentation, her demeanor was bright, alert and responsive, and she displayed an enthusiastic appetite and some weight bearing on the affected limb.

The owners of Heifer X were knowledgeable about cattle and attentive to detail. Hence, they recognized the changes in the heifer's behavior immediately, made a reasonable diagnosis and acted promptly to seek veterinary care. There was a strong human-animal relationship, since the calm temperament of Heifer X resulted in her being shown as the project of the 9-year-old grand-daughter at the prestigious Denver Livestock Show. The grand-daughter and heifer were reported to be "inseparable". The heifer had high genetic merit, and was insured, which provided options for surgical intervention.

The Lloyd Veterinary Medical Center was in close proximity to the home farm, and the veterinary team included a surgeon with skills for fracture repair. Clinical scoring criteria were determined to monitor the heifer's welfare and prognosis prior to and following surgery. Postural and behavior-related changes associated with bovine pain were explained to and scored by the veterinary student assigned to her case, and he was highly motivated to provide supportive care. Pain management was provided throughout her convalescence, and at the point where prognosis became poor, evidence relevant to humane end-points was communicated to the owner. These criteria included duration of refusal to rise from recumbency, refusal to eat concentrate feed, a "tucked up" posture, ear position, lethargy (failure to attend to novel stimuli).

Once the decision for euthanasia was recommended by the veterinary team and agreed upon by the owner and by the insurance company, the procedure was performed in her hospital pen using captive bolt. The veterinarian performing the euthanasia was skilled with the methods, and his standard operating procedures included immediate testing for insensibility and confirmation of cardiac cessation.

Care of the compromised cow - ensuring welfare for involuntary culls

Farmers and veterinarians take care of food producing animals with the aim to keep them healthy, productive and to avoid suffering.

Although preventive care and identification of risk factors are active areas of research, there has been scant guidance on the design and management of hospital pens. In a 2009 survey of dairy farmers in Iowa by our research group, 79 % of farms had the possibility to move sick or injured cows away from the main group. Cow comfort, well-being and the ease of observation of the individual cow were the three most important reasons for moving a cow into a hospital pen. However, fresh cows (46 %), calving cows (35 %) and close-up cows (35 %) were quite often held in the same enclosure as the hospitalized animals. This mixing of ill and injured cows with healthy prepartum cows is of concern due to potential transmission of infection and due to differing behavioral needs of the convalescent and parturitent cow. Further research is needed for effective management of the hospital pen in both dairy and beef herds. In addition, precise terminology ("hospital pens" versus "special needs pens" or "close up pens") is important for emphasizing the different function and care needed for the convalescent cow.

Culling, euthanasia and mortality on dairy farms

On a daily basis, farmers and veterinarians have to make decisions to remove compromised animals from the farm that are ill or injured. These animals may be sold, slaughtered, euthanized on farm or in worst-case scenario, left to linger. Some good decision making trees for determining animals fit for transport have been developed for legislation and voluntary guidelines. Until recently, it has been difficult to determine from farm records the prevalence of different categories of culling: animals that are sold, die unassisted or are euthanized on farm. However, following the BSE crisis some of this information is being collected in Europe and North America, systematically or in surveys (Table 1).

In the USDA NAHMS Dairy 2007 survey, 5.7 % of cows died with predominant reasons including lameness or injury (1.1%), calving difficulties (0.9 %), mastitis (0.9 %) and unknown reasons (0.8 %). These values are similar to those reported for Denmark, and appear to also show an increasing trend (Thomsen & Sorensen, 2008). As of 2007 farmers must report if a cow died unassisted or was euthanized for the

YEAR	MORTALITY	COUNTRY	REFERENCE
1990	2 %	Denmark	Thomsen et al. 2004
1996	3.8 %	USA	USDA 2007b
2001	4.7 %	Denmark	Thomsen et al. 2004
2002	4.8 %	USA	USDA 2007b
2005	4.9 %	Denmark	Thomsen & Sorensen 2008
	3.7 %	France	Roboisson et al. 2011
2006	3.8 %	France	Roboisson et al. 2011
	5.7 %	USA	USDA 2007a
	6.4 %	USA (Colorado)	McConnel et al. 2009

Table 1.
On-farm mortality prevalence on dairy farms.

Danish Dairy Database. In the 2008 Danish database, 83.4 % of cows died unassisted and 16.6 % were euthanized (Thomsen et al. 2009), versus 45 % and 55 % respectively previously reported (Thomsen et al. 2004). A survey of dairy cow mortality in Colorado, US indicated that 55.3 % of the mortalities were unassisted, and 44.7 % were euthanized (McConnel et al. 2009). These differences may reflect changes in thresholds for euthanasia due to greater oversight of slaughter of animals unfit for transport. Similarly, following legislation forbidding transport of non-ambulatory cattle in the EU in 2007, a survey of four veterinary practices in the Netherlands revealed 247 cases of emergency killing and 742 cases of euthanasia in 2007 versus 38 cases of emergency killing and 414 cases of euthanasia in 2006 (Remijn & Stassen, 2010).

As on-farm euthanasia becomes increasingly common, bovine veterinarians have an important role to play in ensuring that stockpeople are trained in effective decision making trees for determining humane endpoints and approved methods of euthanasia. In a survey of 49 dairy farms in the Netherlands, 80 % of farmers recognized that a cow with a broken limb should not be transported (Remijn & Stassen 2010), whereas it was believed that transport was suitable for cows that were lame (68 %), feverish (61 %) or severely malnourished (79 %).

In a 2009 survey of dairy farmers in Iowa by our research group, 58 % of respondents reported that a cow was euthanized during the previous year (unpublished data). Gunshot (81 %) and lethal injection (17 %) were preferred methods. Most often, the owner or staff carried out the procedure (72 % and 16 %, respectively), and 41 % of the people performing euthanasia were trained by a veterinarian versus 36 % who learned on the farm, and 14 % did not receive any training. Similarly, a survey of 113 dairy farmers in the Midwest USA indicated that gunshot was the preferred method for on-farm euthanasia (85.7 %), followed by IV administration of euthanasia solution (8 %) and only one farmer used a captive bolt device (Fulwinder et al. 2008). Of particular concern is the finding that farmers using lethal injection included veterinarians in the procedures only 50 % of the time, which would be required for barbiturate overdose based on licensing of a controlled drug. Disinfectants, such as chlorhexidine, were used on some farms as a euthanasia solution – a technique not approved by the AVMA and likely to cause significant pain and distress.

Euthanasia training and certificates of completion for cattle, swine and poultry producers (and veterinarians) are increasingly common requests at Iowa State University veterinary college, perhaps due to evolving technologies and public scrutiny, with educational programs and resources available (ie: http://vetmed.iastate.edu/HumaneEuthanasia). Euthanasia training programs and support for livestock producers are important not only to transfer knowledge about approved methods, but to provide social support for the psychosocial effects and worker-related stress associated with euthanasia (Mort et al. 2008).

Conclusions

In conclusion, the topics of culling, euthanasia and mortality are increasingly important for the dairy veterinarian and producer due to public scrutiny, changing regulations and emerging technologies. Stockperson support is needed, especially for managing the hospital pen, training in euthanasia and humane endpoints.

Research is needed for evidence based decisions for management and design of hospital pens and compromised cows. The bovine veterinarian has a critical role for training and developing standard operating procedures for these production scenarios.

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Prof. Dr. Elsbeth Stassen

Elsbeth Stassen has studied veterinary medicine at Utrecht University. She received her PhD with distinction at Utrecht University. In 1988 she became associated professor at the department of Farm Animal Health of the Veterinary Faculty, Utrecht University. Between 1996 and 2004 she held the chair of professor in 'human animal relationship'. In 2004 she has been appointed as professor of 'Animals and Society' at Wageningen University, with special focus on animal welfare and animal ethics. She is / has been supervisor of a number of PhD students as in the NWO (Royal Dutch Organisation of Scientific Research)-programmes 'Limits to welfare and animal production' and 'Ethics and Policy'. She has been supervisor and promoter of a number of PhD students in the field of udder health and claw-and-locomotion problems in dairy cattle. Projects such as 'socio-economic aspects of locomotion problems in dairy cattle', 'piglet vitality' and 'animal welfare and public health: a contradiction?' are currently running.

Elsbeth Stassen is or has been member of several committees in the field of animal health, animal welfare and human animal relations such as: chairperson of the ethical committee of the Royal Netherlands Veterinary Association (1997 – 2011), chairperson of the ethics committee for experimental animal use of the Institute for Animal Science and Health, chairperson of the ethics committee of the European Association of Animal Production, member of the scientific European Committee for the moratorium on BST (1999), member of the think-tank (cie Wijffels) commissioned by the minister of Agriculture, Nature Management and Food to advice about the future of the livestock production sector in Dutch society after the outbreak of Foot and Mouth Disease in the Netherlands in 2001, member of the welfare committee to supervise during the control of the Avian Influenza outbreak (2003).

Elsbeth Stassen is teaching in the field of welfare and ethics of production, recreational and companion animals both at Wageningen University and at the Veterinary Faculty of Utrecht University.

Is culling of unproductive animals ethically justified?

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Abstract

Societal concern has emerged about the treatment of animals in agricultural systems. In current farming systems less productive and unproductive healthy animals are being culled. The killing of animals is often experienced as being morally problematic. In this paper longevity will be considered as a morally relevant aspect in the discussion on killing of animals and as a constitutive element of animal welfare. This paper will also present results of a study on the moral and social acceptability of killing animals. In society it is considered unacceptable to indiscriminately kill animals; there must always be a specific reason to do so. 'Respect for life' is a guiding principle, which informs people's understandings and actions with regard to killing animals.

Introduction

The last centuries has seen a major change in the mentality and attitude towards animals. With this development societal concern has emerged about the treatment of animals in agricultural systems. The killing of animals is often experienced as being morally problematic.

Why is there an increasing concern in society about farm animals? For centuries more than half of the Western population was engaged in agriculture. However, nowadays more people keep pets for company or backyard animals for hobby than people that are involved in agriculture. In Western societies most people that keep pets view them as 'members of the family'. With this development views on animals have changed in society. Another reason for the increased concern are the changes in the nature of keeping farm animals. In traditional agriculture the system and treatment of the animals fitted better with the behavioural needs and interests of the animals, because farmers were only able to keep a limited number of animals. The individual animals represented a considerable value to the farmer (Rollin, 2004). In that system productivity was linked stronger to the welfare of the animals. The demand for cheap food of a constant quality increased considerably last decades. Agriculture and science responded by introducing new technologies that made the development of industrial agriculture possible, where the animals (in large herds) were not able anymore to fulfil species-specific needs. Farmers care about their animals, however, the care is mainly based on the extrinsic value because most farmers in industrial agriculture view their animals from a productive perspective. Farmers consider most other people ignorant and misguided of the care that they provide to their animals. Webster (2001) states that, ‘as farm animals are merely seen as resources there is a moral obligation to protect them as they can’t speak for themselves’. Although the vast majority of people in Europe are in favour of the use of animals, they also want the animals to live lives that respect their natures and needs, and thus prevent them from health and welfare problems. The question could be raised why do people find it important to respect the nature and the needs of an animal? Research shows that a majority of people consider humans to be superior to animals (Cohen et al, 2012). However, nearly all people in society hold the conviction that animals have value, that people should do good to all animals and that all animals have a right to life. These convictions are based on a number of arguments, such as animals are living beings, animals have the ability to feel pain and emotions (sentience) and people recognise the importance of animals for the ecosystem (Cohen et al, 2012). So, on moral grounds our concern for animals should be determined by our respect for the intrinsic value of animals rather than for its extrinsic value to us. Dutch legislation on animals sets respect for the intrinsic value of animals as the starting principle for the use and treatment of animals.

Longevity as a welfare issue

In current farming systems, in order to run a profitable farm, less productive and unproductive healthy animals are being culled. In this paper we will explore whether longevity is a morally relevant aspect in the discussion on killing of animals and if it is a constitutive element of animal welfare. Concern about the lifespan of farm animals have been put forward by the Farm Animal Welfare Council (FAWC 2009), who stated that an increase in lifespan is desirable and possible. As outlined in the introduction, the interests of farmers and animals diverge in the conflict between the production of safe and cheap food in sufficient quantities and the interest of the animals to fulfil species-specific needs (Rollin, 2004). Both biological and normative assumptions define to what extent an animal has interests, what these interests are and what they imply for our dealings with animals. It is often considered that death and longevity are not a welfare issue (e.g. Webster 1995). From this perspective, the moral intuition that killing includes a moral wrong is not denied, but it is argued that longevity is not a legitimate argument to substantiate this intuition. This view argues that longevity is not relevant because animals have no or an insufficient concept of time. Consequently they lack the awareness of their future and cannot weigh future live against current live. In contrast, Bradley (2009) states: “there is no good reason to discount the badness of death for an animal. If an animal would have had a good life, then killing it is bad for it, even if it cannot contemplate its future”. From this view being alive is a precondition. Another argument can be that animals have a preference to survive. However, the desire to stay alive needs to be balanced against other preferences of the animal and of other sentient beings involved. The preference of animals to stay alive and live a longer life relates to empirical questions about consciousness and the capacity to have a minimum idea of concepts such as life, death and future. The possibility that animals have some future orientation illustrates that longevity can serve as an independent moral argument in the culling debate, based on precautionary reasoning.

The relationship between humans and animals has evolved from a functional relationship towards one in which respect for the intrinsic value of the animal as a being in its own rights plays a significant role. With that the aspect of natural living has become more and more important in society. Leading to an integral assessment of the quality of life of an animal and taking into account species-specific development. The interests of the animals get more weight if one starts from the assumption that an animal's ability for species-specific development should be taken seriously. Bruijnis et al. (2012) conclude that longevity should be considered as a constitutive element of animal welfare. This conclusion meets the moral intuition that killing animals raises moral questions. From this perspective there is a clear need to justify the killing of animals because the lifespan of animals receives more value than in the more restricted views on welfare where longevity is not seen as a constitutive element of animal welfare.

Societal and moral attitude towards killing animals

According to the present animal protection laws, the killing of farm animals is not prohibited, when this will occur without undue stress and pain. However, in our society, the killing of animals is often experienced as being morally problematic. Many people believe that the killing of animals should be justified.

The societal and moral acceptability of killing animals has been studied (Rutgers et al, 2003). Most reasons for killing healthy animals concern human interests. Economic motives often form the basis of decisions to send unproductive livestock animals to the slaughterhouse. In this paper we would like to present one example. Respondents were confronted with a question about a dairy cow, which had been yielding insufficient milk for at least a month. Given that keeping and feeding the animal was costing rather than making him money, the farmer chose to send the animal to slaughter. Respondents were asked whether these economic motives provided sufficient grounds to kill the cow. A majority (60.6 %) answered affirmatively, motivated by the fact that dairy cattle are kept for production purposes: yielding milk and ultimately meat also. As the animal entered the food chain slaughter was not considered senseless.

Animals tend to be ranked according to their social value and the role that they play within society. The study by Rutgers et al. (2003) has revealed that it is unacceptable within our society to indiscriminately kill animals; there must always be a specific reason to do so. This suggests the existence of a fundamental and underlying shared understanding that one must not kill animals gratuitously. Moreover, it also suggests that 'respect for life' is a guiding principle, which informs people's understandings and actions with regard to killing animals. Moreover, the study has illustrated that the killing of animals is only socially acceptable when the killing is carried out to achieve a clear and specific accepted objective. In this regard, the study demonstrated that it is, for example, socially acceptable to end an animal's suffering, to slaughter livestock species in order to produce meat and to terminate the life of an animal that is deemed a threat to public health and safety.

Killing of animals becomes problematic when the reason for so doing is considered inadequate or unwarranted. For example, when the reason given is considered groundless or when there are satisfactory alternatives available, which render the termination of animal life unnecessary; for example, the slaughter and destruction of healthy livestock animals as a measure to control the spread of animal disease in spite of the availability of adequate vaccines. This suggests that the basis of societal support is not only determined by the specific species in question and the human relationship to the animal, but also the reason why the animal is being killed and whether there are reasonable alternatives to killing.

The study also revealed a number of other sociologically relevant facts. The most significant divergence in attitudes to killing animals related specifically to gender, with women often articulating greater objections to concrete situations and attaching more value to respect for life arguments than men, who favoured more economic and welfare arguments. This is consistent with the findings of many studies of attitudes towards animals, which also show that women have more affinity and empathy for animals than men. This research also suggests subtle changes in cultural attitudes towards animals throughout time. For example, older respondents tended to display a higher degree of acceptance of killing animals, revealing a more utilitarian and less emotional attitude, than the younger ones. Such disparities reflect broader social and psychological changes in attitudes towards animals that have taken place throughout the past century.

Concluding remarks

- The moral principle of ‘respect for life’, which is understood as having respect for the natural lifespan of the animal, provides an important moral foundation for the common sense belief that animals should not be killed, unless there are reasonable grounds for doing so.
- Longevity is an animal welfare issue; the animal’s future welfare is therefore important as well.
- The slaughter of livestock due to lack of productivity was found to be acceptable, but only if the animal completes its ‘normal’ cycle of production (i.e. slaughtered for meat).

- Healthy animals may be killed when welfare problems are likely to occur.

- All other reasons for killing healthy animal, such as psycho-social, social economic and (public) health considerations, are only considered legitimate grounds for killing animals in specific situations.

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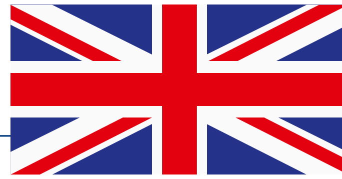
Notes

Karen Lancaster

Karen Lancaster qualified as a Veterinary Surgeon 12 years ago from Glasgow University. She has worked in farm animal practice throughout the UK. Karen spent three years teaching at Cambridge Vet School and completed a Masters degree in livestock Health and Production whilst there. On leaving practice 3 years ago Karen joined DairyCo (the UK dairy levy board) as a technical extension officer providing technical information and training to dairy farmers. In October 2011 Karen began a part time PhD with the Royal Veterinary College investigating the impact of periparturient measures of control on Johne's Disease in British dairy herds.

Karen's particular areas of interest are infectious disease, welfare, production diseases and Cow Signals.

She spends much of her time visiting farms providing practical ways to improve dairy cow welfare and productivity. Karen is a qualified Cow Signals trainer.



Culling factors and culling management strategies on dairy farms

Karen Lancaster
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Introduction

The cost of maintaining the herd *(the cost of rearing replacements or buying them in minus the value of culls sold)* is a major proportion of dairy farm variable costs. Typically second only to feed and forage. This is largely a "hidden" cost unlike the feed bill or veterinary expenses. You never write a cheque for 'culling' or 'herd replacement costs' so this is often a cost which is not calculated or is grossly underestimated.

The table below shows data collected by the DairyCo benchmarking service MilkBench+ from UK dairy farms.

	MB+ data (as £ / cow) to June 2011	MB+ data (ppl) to June 2011
Herd replacement cost	238	3.17
Feed & forage variable costs	622	8.02
Bedding	36	0.47
Vet & medicine	75	0.98
AI and other breeding costs	32	0.42
Milk recording	11	0.15
Consumables & dairy sundries	63	0.85
Total	839	14.06

Milkbench+ database containing datasets with year ends between December 2010 and June 2011, 379 datasets (Milkbench+ uses the average market value for the farm replacement type, thus allowing comparison of flying herds against herds with homebred replacements)

Culling rate is influenced by many factors which must all be understood and managed to ensure both profitability and good animal welfare.

The quote below from the Farm Animal Welfare Council (FAWC) illustrates this complexity:

'Lifespan per se is not necessarily an accurate indicator of good welfare or of a cow having had a good quality of life. A long life often implies that a cow has experienced a reasonable quality of life. A short life, terminated prematurely, suggests that there is likely to have been a previous welfare problem, such as endemic or metabolic disease or injury. Voluntary culling does not normally imply poor or good welfare but the ratio of the two culling rates (voluntary: involuntary) reflects the quality of life of animals in the herd, independently of lifespan. It could be used as a key welfare indicator on dairy farms.' Farm Animal Welfare Council 2009

The following quote is from an online farmers forum.

'I've a very good dairy cow 4 / 5 calver in calve only 2.5 months, nearly dry. would you cull or keep her. she's worth about £550 culled but in 6 + months she'll be a really nice cow with a 50 / 50 chance of having a heifer.'

The opinions that were offered covered every option from 'get rid of her now, she'll only have a bull calf, mastitis, metabolic disease etc' to 'keep her, she's already paid her way and she won't cost you much to keep until she calves'. This is an example of the day to day decisions facing farmers regarding culling.

The UK Situation

In the UK a 2010 study estimated the culling rate to be 25 %, so on average a dairy cow in the UK national herd completes less than 4 lactations. However, there is significant within herd and between herd variations from 11.5 % to over 35 %. The table below shows the level of culling in the UK and the breakdown of reasons for the culls using the example of a 160 cow dairy herd.

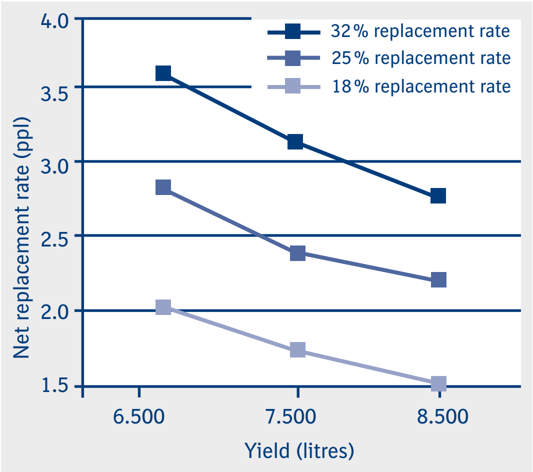
	% of all cows leaving herd	Number of animals leaving herd*
Infertility/failure to conceive	26.4	11
Mastitis/ udder health	15.4	6
Lameness/ legs and feet	10.4	4
Other (including death)	41	16
Yield	2.7	1
Age	4.1	2
Total	100	40

*For a 160 cow herd with a 25 % culling rate. Figures taken from Kingshay report 'Reasons for cows leaving the herd'.

It must always be remembered that lower is not always better and a balance must be struck between keeping the culling rate down whilst not maintaining unproductive or unhealthy cows.

The average age at first calving in the UK is 28 months, with a range from 22 months through to over 40 months. This costs on average £1280 (range £1250 at 22 months - £1528 at 30 months).

The average cost of replacements is currently around 3.2 pence per litre (ppl) in the UK. The target figure should be below 2.6 ppl with a financial gain of around £90 /cow in extra gross margin for achieving this. This is equivalent to £ 14,400 per annum for a 160 cow herd.



Herd replacement cost (ppl) at different yield levels and replacement rates, assuming a £ 730 net replacement cost.

The situation is complicated in large parts of the UK by the impact of Bovine Tuberculosis (bTB) necessitating the premature removal of large numbers of otherwise productive cows.

Culling Rate

Culling is often split into two categories voluntary and involuntary. Voluntary culling is defined as the removal of animals from the herd for production related reasons. An animal will be selected for removal to be replaced by one of higher production potential.


Involuntary (or forced) culling is defined as the removal of animals on the basis of health or fertility problems. This does not include casualties or sudden deaths. The following table gives further detail on these categories.

Voluntary	**Involuntary**
Low yield	Infectious disease
Confirmation	Lameness
Temperament	Non-bulling / repeat breeder
Age	Not in calf
Out of calving pattern	Metabolic disorder
Slow milker	Udder disease
Herd reduction	Calving problems
Poor milk quality	

In an ideal world a cow would calve for the first time at 22 – 24 months, well grown and healthy. Calve every year for at least 6 years, have no mastitis or lameness and produce a good yield of quality milk. Some culling would be necessary as an aged herd would be more prone to disease, and milk yield would begin to decline.

This culling would be for age and age related disease, also to remove some younger animals which fail to reach their milking potential and some which fail to get in calf. However, most of this culling would be the voluntary selection of unprofitable cows, with only the barren cows being involuntary or forced culls.

In reality very few animals are culled for low yields or old age and most fall into the involuntary category and are culled for fertility or health reasons. This leaves farmers with little opportunity to cull for production reasons and so unprofitable animals are retained in the herd.

	Age at calving		
	2 years	**2 years 4 months (average)**	**3 years**
Net replacement cost*	680	730	977
Milk Yield Level	6500 7500 8500	6500 7500 8500	6500 7500 8500
Replacement rate per year			
-Low 18 % £ / cow / year	122	131	176
-Pence per litre sold	1.9 1.6 1.4	2.0 1.7 1.5	2.7 2.3 2.1
-Average 25 % £ / cow / year	170	183	244
-Pence per litre sold	2.6 2.2 2.0	2.8 2.4 2.2	3.8 3.3 2.9
-High 25 % £ / cow / year	218	234	313
-Pence per litre sold	3.4 2.9 2.6	3.6 3.1 2.8	4.8 4.2 3.7

*cost to rear a heifer, less a cull cow at £ 550
DairyCo Managing Herd Replacements

Replacements

In order for a farmer to cull cows from his herd, he must have animals which can come in and replace them. This is achieved through either the breeding of replacement heifers or the purchase of heifers or cows.

The ability to successfully rear heifers to a size at which they can calve down for the first time at 22 – 24 months is pivotal to a profitable dairy farming enterprise.

Rearing a dairy heifer to the appropriate size and weight to calve for the first time is expensive and time consuming especially when we consider that she will not begin to make us a profit until well into her second lactation.

This cost is compounded by the fact that heifer wastage is a big problem on many UK dairy farms. 15 % of heifers fail to reach their first lactation and over 20 % of those heifers which do calve down successfully for the first time will be lost from the herd before they reach their second lactation. This is not only a huge financial drain but also a serious welfare problem.

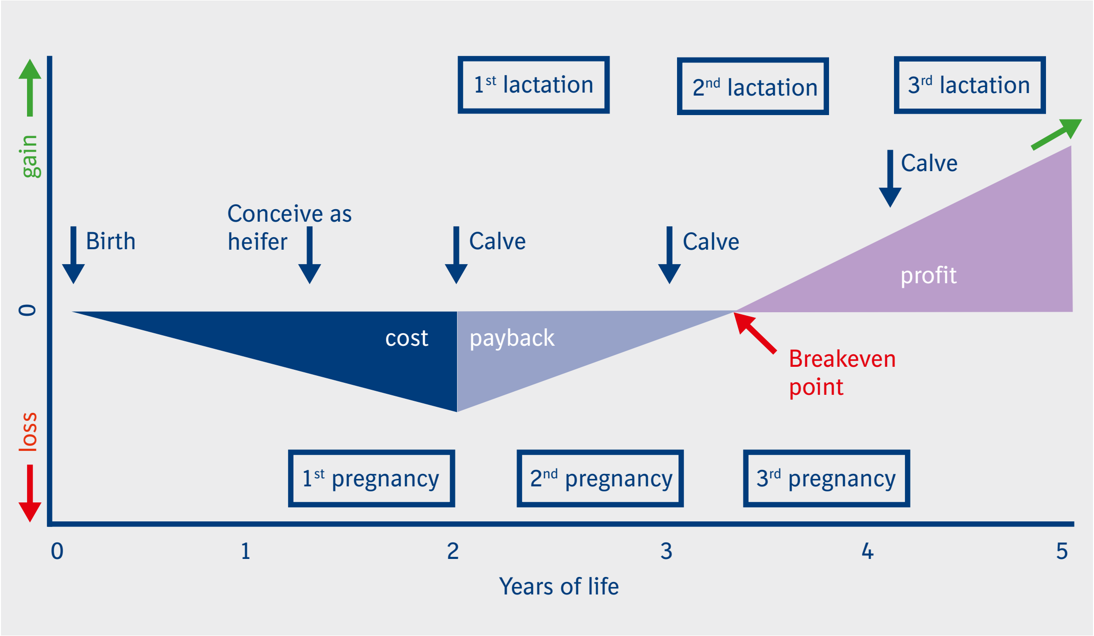
	Timing	Mean	Hard Range
Neonatal	24 h – 1 month	3.4 %	0 – 12 %
Calf	1 – 6 months	3.2 %	0 – 29 %
Juvenile	6 – 15 months	3.5 %	0 – 21 %

Neonatal and Calf Mortality (from Brickell et al. (2009) Animal. 3: 1175 – 1182). Data from 509 heifers from 19 farms.

Conclusions

Culling rates in the UK are very variable and are largely made up of involuntary or forced culls, leaving little room for the voluntary removal of poorly productive animals from the herd.

Figure.
Lifetime Performance of a Dairy Cow



A high herd replacement rate is a costly problem in terms of both finance and animal welfare which is often not recognised on many farms. It will take a many stranded management plan to deal with this problem and it can take several years to get on top of. Never has the old adage 'if you don't measure it, you can't manage it' been more apt.

The main strategies for reducing herd replacement rates are:

- An emphasis on herd health to reduce the number of involuntary/forced culls through disease and infertility.
- Decrease the age at first calving to the optimum of 22-24 months by improving heifer rearing and producing well grown, healthy heifers.

By reducing the number of involuntary culls this will allow more voluntary culls to be chosen improving the quality of the herd and also the monetary value of the culls sent.

Lame cow.

When culling rates go down this reduces the number of replacements needed and with a lower age at first calving the number of heifers which need to be kept will be further reduced. This gives additional opportunities to either sell surplus heifers, breed more cows to beef bulls or reduce the amount of space used for heifer rearing.

With many dairy farmers struggling to make ends meet and a growing consumer awareness of animal welfare, improving dairy replacement rates has to be a priority for the UK dairy industry.

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Fritha Langford

I am a post-doctoral researcher in animal welfare science at the Scottish Agricultural College (SAC) and have mainly been working in the area of dairy cow behaviour and welfare. I have worked on several large-scale projects on both commercial dairy farms and research units. I have run a project to specifically address the potential social behaviour issues associated with continuous housing of dairy cows. I recently carried out stochastic modelling and written a report for Dairy Co on the issues surrounding the culling of dairy cattle.

I am passionate about promoting animal welfare education. I lead the education section of the EU-funded project Animal Welfare Indicators (AWIN) developing 'Learning Objects' that take high-quality research from the AWIN project and other areas of animal welfare science and turn them into easily accessed educational material for many audience types. I have been involved with the University of Edinburgh MSc in Applied Animal Behaviour and Animal Welfare for many years and have been Module co-leader for Farm and Lab Animal Welfare (she does the farm half) since 2007. I also teach undergraduate causes at SAC making full use of virtual learning environments and video conference to engage students in college sites across Scotland. I also teach veterinary students within the University of Edinburgh and disadvantaged school-leavers in the Scottish schools LEAP scheme. I have recently taken on the challenge of starting up and running a new Masters course on International Animal Welfare, Ethics and Law entirely delivered using online methods.

Culling early or culling late – A trade off between farm profits and cow welfare?

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Introduction

Dairy cows are culled at the end of their productive life, if there is an untreatable health or welfare problem, or if the cow is unable to become pregnant during lactation. The overall level of culling varies widely from farm to farm. Moreover, the rates at which cows are culled 'voluntarily' (i.e. the farmer makes the choice to cull the cow for poor yield, age or confirmation) or 'involuntarily' (i.e. all disease, infertility, accident and death culls) vary even more widely between farms. When an animal is culled during her productive life, what the cause of culling is and whether or not she can be a 'sale cull' (i.e. has not died or been euthanized on farm) affects the financial cost of culling the cow for the farmer. These same factors can affect the quantity and quality of life experienced by the cow and her welfare prior to culling. However, the 'types' of culls that are most expensive for a farm's finances are not necessarily the same as those that have the highest potential for poor welfare and this creates a potential trade-off between the financial outcomes and the avoidance of suffering.

To gain an understanding of the long-term effects of improving welfare on dairy farm finances a dynamic programming model was used to investigate the relationship between the causes of culling and the consequences of the cull, in terms of economics and health outcomes.

Culling dairy cows: reasons and rates

There are two main reasons why culling occurs (Fetrow et al. 2006). Animals that the farmer chooses to cull for his/her own reasons are culled 'voluntarily' (Voluntary culling: VC). The reasons for a VC include low yield (when a heifer of higher potential is available), poor confirmation (the cow is not wanted for breeding) and age (yield drops with age and there is an increase in the probability of disease). VCs are usually sold for slaughter into the human food chain. 'Involuntary culling' (IC) is where a farmer must dispose of a cow before he / she would otherwise choose to because of injury, poor health or infertility in the cow. IC cows may be milked partway or throughout the lactation and sold direct to slaughter, IC also includes those cows that die on-farm due to accident, injury or are euthanized.

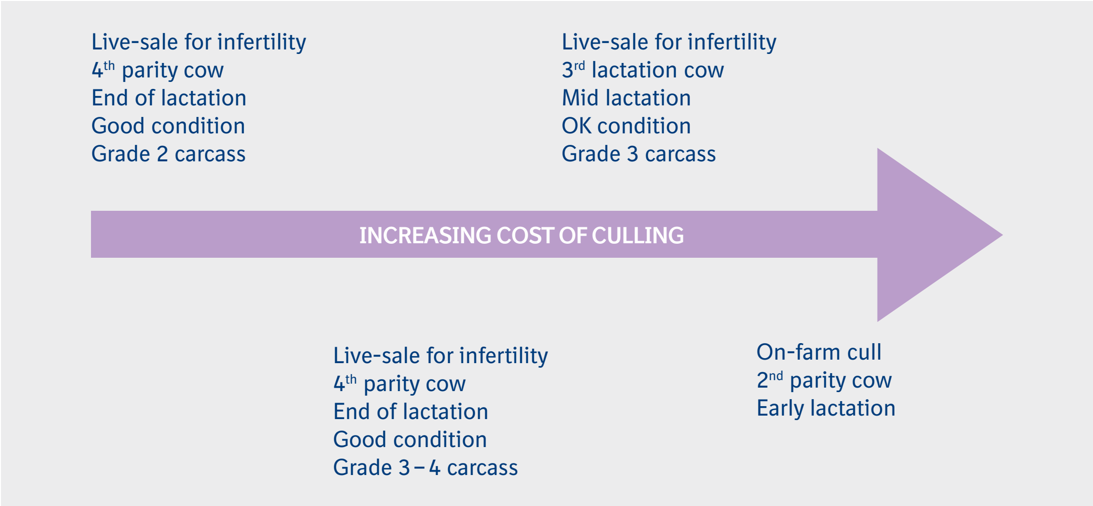
Total culling rates include both VC and IC. Recent studies have estimated the UK total culling rate to be 22 – 25 % per year (Bell et al 2010; Orpin & Esslemont 2010; Whitaker et al 2000). This is lower than the USA rate and comparable to other countries in the EU. The percentage of total culling which is classified as VC is often below 10% (8.8 % Bell et al. 2010; 2.9 % Orpin & Esslemont 2010; ~3 % Brickell & Wathes 2011; 5.7 % Whitaker et al. 2000). Therefore the majority of culling is unexpected or unplanned (and so is IC) and in order to maintain herd size the farmer is less able to make choices to improve his or her herd. It may also lead to cows that would have been culled for health issues remaining on farm as long as they get pregnant. The most common reasons for IC are 'infertility' (Beaudeau et al. 1993; Bascom & Young 1998) followed by mastitis (Bar et al. 2008), lameness (Booth et al. 2004) and uterine infection (Bell & Roberts 2007).

How the financial costs of culling differ between 'types' of cull

As milk yield tends to drop after the fifth parity and the likelihood of disease (such as Johne's) increases with age, it becomes economically attractive to 'voluntarily' cull cows after the fifth parity (Stott, 1994). Cows that have five parities are extremely likely to have made more money than they cost to rear and feed. Of course, most cows do not survive to their fifth parity due to disease or infertility. Orpin and Esslemont (2010) calculated losses for the different IC types and found that farms with the same culling rate may vary considerably in costs of culling, as the reason or timing of culling explains the majority of the variation in cost.

A cow that is culled at the start of her first lactation will have cost the farmer more money to raise than she has made in milk. When the cow will start to make a positive financial contribution to the farm will depend on the number of parities, the milk yield of the cow, the point within a lactation that she is culled and the veterinary cost of treatments. Added to this, the farmer may make some money through a live sale to slaughter, or a loss if the cow is culled on farm and the carcass has to be disposed of (figure 1).

Figure 1. Financial costs of different types of culling.



The effect of the 'type' of cull on the welfare of the cow

The welfare of the cow is affected by different aspects of the factors leading to culling than the financial outcomes. There is a potential for conflict in this trade-off between farm profits and cow welfare. What if we were to look at culling decisions from a cow's point of view? As a cow never has this choice, perhaps we should ask the alternative question of when would the farmer cull the cow if he/she were interested in maximising the cows' welfare? A cull early in lactation, especially for a young animal is the most expensive financially for the farmer, but might this type of cull be preferable to a cow then some of the other culling scenarios common on farm? A cow is only culled on-farm under extreme circumstances, e.g. severe mastitis that does not respond well to treatment. Cows that need to be culled on-farm usually receive prompt veterinary treatment, and the euthanasia itself would be humane (and less stressful than going to market). Notwithstanding the cows' potential, especially if she is only in her first or second parity, to have a good life in the future if it were able to 'pull through' from such a poor welfare incident (see Yeates 2010), it is possible that culling at this point would be preferable to other prolonged conditions leading to culling.

Many dairy cows that go to market at the end of lactation are in a poor body condition and this can be associated with chronic lameness and other conditions which may have been inadequately treated (Machado et al. 2010). These cows are often nominally culled for 'infertility' as the farmer is unable to get the cow pregnant (Dobson et al. 2008). From the cows' perspective, the pain of lameness and the prolonged length of time the condition occurs could be worse than the on-farm cull scenario presented above. We could illustrate this in a similar fashion to the financial outcomes as shown in figure 2.

Modelling long-term welfare improvement effects on culling and farm finances

A model was devised to investigate the effects of small husbandry modifications to improve health, welfare and fertility on financial out-

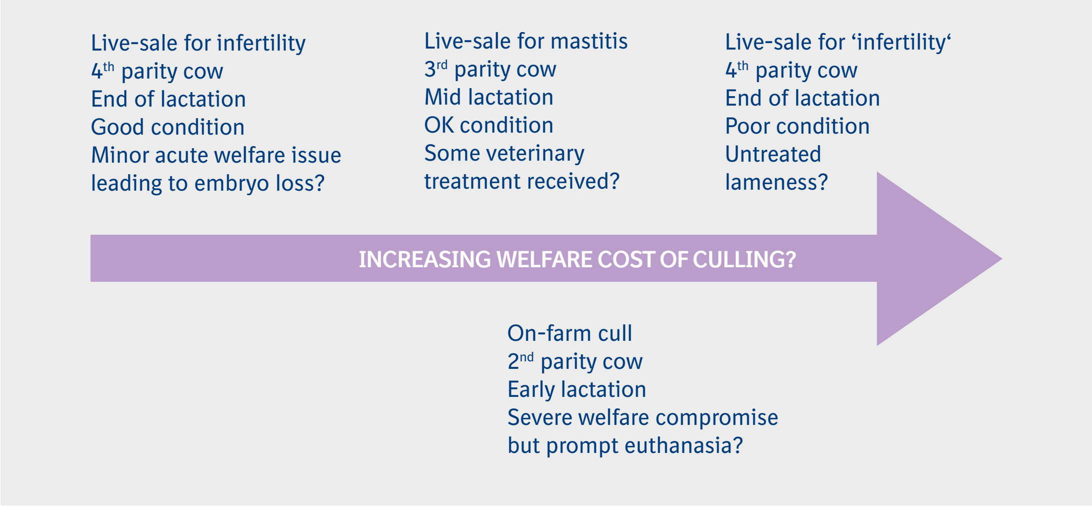


Figure 2. Welfare costs of different types of culling.

comes over the long-term. The basis for the long-term model was a computer based ‘typical herd’. The ‘Dynamic Program’ (DP – Kennedy, 1986) concerned used recent data from research and markets to create the ‘typical herd’. In order to apply to as many farmers as possible a ‘typical herd’ for two differing but not extreme systems, a high input and a low input system was produced. Then, by using the likely economic benefit to the farm of culling an animal, the DP calculated the optimum culling strategies under pre-determined scenarios. These scenarios were low rates of infertility, low rates of mastitis and low rates of lameness and average scenarios for each trait.

Figure 3. Effect of improving disease and infertility over the long-term (20 years) on milk yield in two different dairy farm systems.

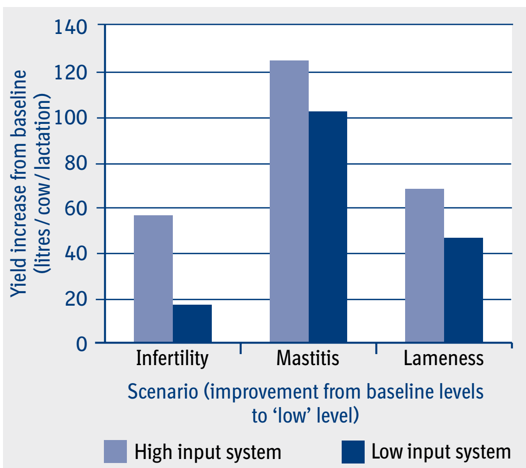
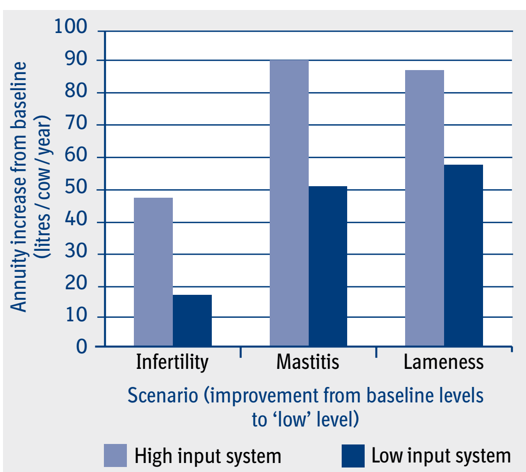


Figure 4. Effect of improving disease and infertility over the long-term (20 years) on annuities (£/cow/year) in two different dairy farm systems.



The scenarios changed the inputs to the model, reflecting how the condition alters every area of the herd. The DP model was run to obtain the highest economic output from the herd while applying these different criteria, to study how farmers should optimise their cow culling under the different disease and infertility scenarios and their systems.

Reducing the herds’ infertility and disease rates from the baseline to the ‘low’ level increased the milk yield in both systems (Figure 3), especially reducing mastitis levels. Reducing the herds’ infertility rates from the baseline to the ‘low’ level increased the annuity (average annualised net return from investment in dairy farming in £/cow/year) by £ 18 in the low input system (from £196 / cow / year) and £ 48 in the high input system (from £ 549 / cow / year). The average age of the herd (i.e. parities) increased by 0.1 and 0.2 for the low (from 3.2) and high input systems (from 2.9) respectively. Both mastitis and lameness had an even greater effect on the annuity predicted, with lowering mastitis levels increasing the annuity by £ 51 (low input) and £ 90 (high input) and lowering lameness levels increasing the annuity by £ 57 (low input) and £ 87 (high input) (Figure 4). These figures take additional costs (veterinary treatments and preventative measures) into account. These increases in annuity were mainly achieved by the increase in milk yield for the mastitis scenario and a combination of


increased yield and a reduction of cows culled on farm for the lameness scenario. This shows the effect that reducing disease can have on a farm's cash flow, accounting for up to 30 % improvement in annuity from one cause alone (lameness in low input systems). Although these effects will not be additive, due to interactions between diseases / conditions, efforts to improve performance across the board from the typical baseline used here to current good performance will provide even more financial benefit than these single issue results.

Conclusion

We should conclude overall that from the financial position, it is best to avoid on-farm culls and from the welfare position it is best to avoid the chronic suffering potential of the low-value end of lactation 'infertility and other causes' cull. Fortunately, the model results show that with added investment and care to reduce the three main causes of culling, farmers will end up in the long-term reducing both of these culling types especially for cows in their first few parities. Improving welfare of lactating dairy cows by reducing mastitis, lameness and infertility increases: the mean longevity of the herd; the choices that the farmer can make in terms of herd improvement by increasing VC potential; the milk yield from the cows by reducing losses - directly due to disease and indirectly due to culling during lactation; and also the annuities for each cow (£ / cow / year) mainly by increasing milk yield and reducing costly on-farm culls. This is undoubtedly a win-win situation for both farmer and cow.

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Notes

Prof. Marina von Keyserlingk and Prof. Dan Weary

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

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

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

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

Improving the welfare of the transition cow

Prof. Marina A. G. von Keyserlingk and Prof. Daniel M. Weary
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Introduction

Ensuring a reasonably constant level of milk production requires that cows give birth once a year. Despite the frequency of this occurrence, the period around calving is one of the points in dairy production where risks to animal welfare are highest (von Keyserlingk et al. 2009). During this period, cows face a number of stressors including diet changes and social regrouping, and the physical, hormonal and physiological changes associated with calving and the onset of lactation. Cows are also especially vulnerable to metabolic and infectious diseases during the transition period, making early detection of disease particularly valuable at this time.

The majority of research on health issues in transition dairy cows has focused on nutrition, physiology and metabolism. Our work has instead focused on the behavioural changes that occur during the transition period and the relationships between behaviour, including feeding behaviour and health status after calving. This paper reviews nearly a decade of research by our research group that describes behavioural changes over the transition period and links these behaviours with disease (specifically metritis) after calving.

Parturition: Where and When

Although cows are naturally gregarious, it has been reasonably well accepted the onset of maternal behaviour in free ranging cattle begins in the hours when cows isolate themselves from herd mates and choose a nesting site before calving (Lidfors et al. 1994). However, when cows are kept at higher stocking densities (3 cows/ha; Owens and Edey, 1984 / 85), or housed indoors (Edwards, 1983), this tendency to separate from herd mates is less evident. Intensively housed dairy facilities are man-

aged such that cows are now housed at higher densities than that described in the previous work and either moved to individual maternity pens or left to calf in large groups where they are provided much less space than found under more natural conditions. Unfortunately there is a dearth of experimental work investigating whether these sort of calving environments work well from the cow's perspective. Our research group has recently initiated a number of studies on this topic; early results suggest that intensively housed cows do prefer to separate themselves from conspecifics at the time of calving, and that preventing this behaviour may increase the risk of disease.

Little research has also addressed when cows calve. In one study we followed the calving times of 100 Holstein dairy cows housed indoors in a free stall barn and found that the majority of cows tended to calve in the later part of the afternoon and early evening (von Keyserlingk and Weary 2007). This diurnal pattern may be due to selective advantages of calving at different times, or may simply relate to management practices on the farm.

Changes in behaviour around the time of calving

In some of our first work in this area we investigated the changes in feeding and lying behaviour of cows monitored from 10 d before until 10 d after calving (Huzzey et al. 2005). The daily time spent feeding was variable during the period before calving, but averaged 86.8 ± 2.95 min / d. Immediately after calving feeding times dropped to 61.7±2.95 min / d, perhaps because feeding rate increased likely due to the switch to a higher energy postpartum diet. In the days after calving feeding times slowly increased (at a rate of 3.3 min / d), in agreement with other studies showing a gradual increase in dry matter intake (DMI) required to support increasing milk production (Kertz et al. 1991).

Healthy cows stood on average for 12.3 and 13.4 h / d during the pre- and post-partum period, which is not much different than during other stages of lactation, but there was a dramatic increase in the number of standing bouts from 2 days before calving to the day of calving (Huzzey et al. 2005; Proudfoot et al. 2009). This result suggests that cows were more restless, likely due to the discomfort associated with calving, and suggests that special attention should be placed on cow comfort in the maternity pen.

Changes in Behaviour Predict Illness Around Calving

In a number of studies we have assessed whether cows that became ill with metritis after calving behaved differently than healthy cows (Urton et al. 2005; Huzzey et al. 2007). In the latter study, we followed the DMI of 101 cows from 14 days before calving to 21 days after calving.

Cows that developed metritis or severe metritis ate less than healthy cows in the pre-partum period, up to 10 d before the disease was diagnosed. Feeding time was also measured and showed the same pattern. With every 10-minute decline in feeding time in the pre-partum period, the odds of cows becoming ill doubled. This work provides evidence that reduced feeding time and DMI during the period before calving increases the risk of cows being diagnosed with metritis after calving. However, whether a reduction in intake and feeding time before calving is a cause of metritis or an effect of something else going on during the prepartum

period, is not known. Social behaviour in the pre-partum period was measured, as this is likely influenced by the many challenges during transition. Cows that developed post-partum metritis also engaged in fewer aggressive interactions at the feed bunk during the week prior to calving and avoided the feed bunk during periods when competition for feed is highest. Not surprisingly, metritis reduces feed intake around calving, lowers 305-day milk yield, and increases culling risk in multiparous cows. (Wittrock et al. 2010; von Keyserlingk and Weary, 2010).

Ample evidence now suggests that detailed knowledge of behaviour can help identify cows at risk for disease in transition dairy cows. This information can also guide the development of management practices that can:
1) help detect disease early and 2) help prevent disease by addressing management challenges during transition that might influence these risky behaviours (i.e., decrease feed intake and increase standing time). However, we encourage readers to think critically as it is important to think carefully about the causal links: does the behaviour increase the risks of illness or does illness cause changes in behaviour (see reviews by Weary et al. 2009 and Proudfoot et al. 2012)? In some cases these links can be complex. Changes in behaviour might be due to a general feeling of malaise, and the behavioural changes may exacerbate the original condition or increase the risk of the animal succumbing to clinical illness. This area clearly requires more scientific work.

Conclusion

Our work continues to focus on cow behaviour around calving, how these behaviours are affected by management and housing, and how these behaviours can be used to better identify health problems affecting transition cows. Many questions remain. For example, current work is studying if, when provided the opportunity, cows will separate themselves from herd mates before calving, and whether preventing this behaviour increases the risk of disease? We strongly encourage additional work on cow behaviour in the period around calving. Our hope is that this work will provide the basis for science-based recommendations that improve the welfare and health of transition dairy cows.

Acknowledgement

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Notes

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Kenneth graduated with a BVSc from The University of Pretoria in 1995. After graduating he joined small animal practice in Johannesburg for 2 years before returning to the University of Pretoria. In 2000 he obtained a MMedVet (Anaes) and held the position of senior lecturer in anaesthesiology at the university. In 2004 he left the university to re-join private practice before starting his own referral practice in anaesthesiology, pain management and critical care. Kenneth has publish 33 scientific publications, delivered 53 scientific presentations, delivered over 120 continuing education talks, done 9 multimedia presentations, published 35 non-scientific articles, presented 3 course, written one book chapter and attended 55 congress of continuing education. Kenneth currently holds a extra-ordinary lecturing post in Pharmacology in the department of Paraclinical Sciences at the University of Pretoria and runs a private practice dedicated to anaesthesia, analgesia and critical care. He has regularly examined students in pharmacology, anaesthesiology and clinical studies.

Kenneth has a keen interest in total intravenous anaesthesia, intensive care, ventilation and cardiology. His research interests included non-steroidal anti-inflammatory agents, anaesthetic depth monitoring and total intra-venous anaesthesia.

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Practical methods to reduce pain associated with obstetrical procedures in cattle

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Introduction

Providing analgesia to cattle during the peripartum period is extremely complex as meat and milk withdrawal times need to be considered, there are only a few medications registered for use in cattle, humane handling is becoming a requirement and the economic value of these interventions is not fully understood. Pain in the peri-partum period can either be a result of the birthing process, complication during partus (e.g. dystocia) or a result of interventions to relieve the dystocia (caesarian or manipulation of the foetus). Effective analgesia and relaxation of the uterus can be an invaluable aid when resolving a dystocia. No analgesics are usually given for normal partus.

Four broad categories of drugs are generally available for the treatment of pain: non-steroidal anti-inflammatory drugs, opioids, alpha$_2$ agonists and local anaesthetics drugs. Local anaesthetic agents are either used alone or combined with alpha$_2$ agonists or opioids when used for regional anaesthesia.

Most procedures are conducted under sedation with analgesia. General anaesthesia is not used as a routine in peri-partum cattle.

Sedation

The use of alpha$_2$ agonists in ruminants iscommonplace. Dramatic breed differences in the sensitivity of animals to alpha$_2$ agonists are well known. Bos indicus breeds are particularly sensitivity. Alpha$_2$ agonists are very effective sedative hypnotics and analgesic in cattle, sheep and goats. Hypoxia has been documented in ruminants following the administration of alpha$_2$ agonists. Cardiovascular changes include a dramatic reduction in heart rate, an increase in blood pressure (raise systemic vascular resistance) and a reduction in cardiac output. Alpha$_2$ agonists should only be used in healthy animals. Alpha$_2$ agonists should be used with caution in small ruminants, as hypoxia can become life threatening. The pathophysiology behind hypoxia in sheep has been shown to be as a result of acute pulmonary oedema. The pulmonary oedema is the result of an interaction between the alpha$_2$ agonists and the pulmonary macrophage. Alternative sedatives should be used in sheep and goats. Alpha$_2$ agonists' abolishes the swallowing reflex and predisposes the patient to the risk of aspiration.

All the alpha$_2$ agonists may be used in cattle Cattle appear to be less sensitive to detomidine than xylazine and doses similar to that used in horses are used in cattle. Detomidine was detected in milk for 23 hours after administration and in muscle for 48 hours. Medetomidine and romifidine has been used in cattle. Alpha$_2$ agonists are very effective in reducing anaesthetic requirements.

In pregnant animals, alpha$_2$ agonists should be used with caution as they can increase uterine tone. This can result in abortions. All the alpha$_2$ agonists can be reversed. Atipamezole and yohimbine can be used to reverse all of the alpha$_2$ agonists. Reversal can improve the safety of alpha$_2$ agonists.

Acetylpromazine is not commonly used in ruminants but may be very effective in sedentary animals. Acetylpromazine does reduce anaesthetic requirements although clinical sedation is not dramatic. Caution should be exercised in sick, debilitated and hypovolaemic animals.

Benzodiazepines are a useful alternative in small ruminants to alpha$_2$ agonists. Both diazepam and midazolam have been used successfully and are usually used in combination with ketamine for general anaesthesia. The cardiovascular and respiratory effects are usually not that marked. Benzodiazepines can be reversed with flumazenil. The large volumes required in cattle usually make the administration of benzodiazepines impractical.

Opioids can be combined with sedatives to improve analgesia, deepen sedation and extend the duration of effect. Butorphanol is a mixed agonists antagonist opioid and buprenorphine is partial agonist opioid. The major advantages are a decreased effect on respiration and less legal regulation. The improved analgesia and sedation allows for more invasive procedures to be performed with additional local analgesia and without resorting to general anaesthesia. Muscle relaxation is improved by the administration of opioids and anaesthetic induction doses are reduced. These opioids, at similar dose rates have been used to provide postoperative analgesia.

Opioids can interfere with the LH peak and affect ovulation. This needs to be considered during invasive procedures performed at the time of breeding.

All sedatives and analgesics cross the blood brain barrier and the placenta. This can result is depression of the new born. Reversal agents can be administered through the umbilical vein at delivery to reverse these effects. Alternatively they can be administered if sedation is a problem post delivery.

Agent	Potency	Lipid solubility	pKa	Prot binding	Onset	Duration (min)
Procaine		1	8.9	6 %	Slow	60 – 90
Lidocaine	2	3.6	7.7	65 %	Fast	90 – 200
Mepivacaine	2	2	7.6	75 %	Fast	120 – 240
Bupivacaine	8	30	8.1	95 %	Interm	180 – 600
Ropivacaine			8.1	95 %	Interm	180 – 600

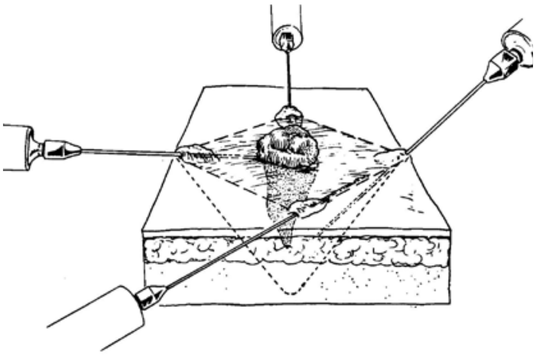
Local Anaesthesia

The term local anaesthesia refers to the use of a chemical agent on sensory and motor neurons to produce a temporary loss of pain sensation and movement. Local anaesthetic blocks are an effective and practical alternative to general anaesthesia. Local anaesthetics work by preventing neuronal transmission from a certain area of the body. They may also stop nerve conduction into this area as well. This results in a loss of sensory and motor function to the area affected. Local anaesthesia may be induced by the administration of drugs, coldness (ethyl chloride, ice) and through transcutaneous electrical nerve stimulation (TENS).

Different types of local anaesthetic blocks have been described based on anatomical location. Surface analgesia refers to the induction of anaesthesia in the superficial layers of the skin. Injection of local anaesthetics into a joint produces intrasynovial analgesia while infiltration of local anaesthetics into an area produces infiltration analgesia. Regional nerve blocks produce analgesia over a wider area than that produced by any of the previously described methods. Regional nerve blocks may require the infiltration of local anaesthetics into areas to remove sensation from the nerves innervating that area. Large nerves or plexuses supplying an area are targeted to remove sensation. Intravenous regional anaesthesia produces anaesthesia through the injection of local anaesthetics into the venous drainage systems of an area after occlusion of the vascular structure with a tourniquet. Spinal anaesthesia refers to epidural and intrathecal administration of local anaesthetic blocks.

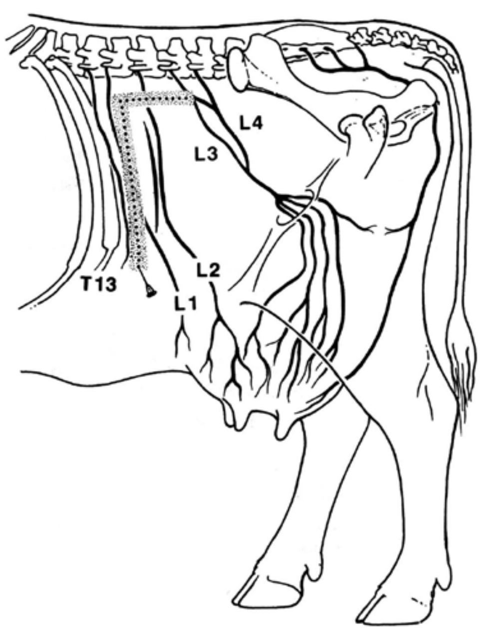
Infiltration Anaesthesia

The infiltration of local anaesthetics is commonly performed in veterinary practice. It is safe, reliable and does not require extensive experience. Sterile sharp needles should be used. If injections are made at the periphery of each weal then only the one needle prick is felt. The recommended dose of lignocaine or mepivacaine for infiltration is 2 – 5 mg / kg. Local anaesthetic should be diluted with 0.9% sodium chloride and not sterile water. The dose should be reduced in old, sick or debilitated animals by 30 or 40 %. Adrenaline at a concentration of 1:200 000 may used to delay the absorption of local anaesthetics and increase the duration of effect. Adrenaline should not be used where an end-arterial supply exists as skin necrosis may result (ears, tails). When surgery of deeper lying tissues is required it is important to sequentially anaesthetise all the layers from superficial to deep. Infiltration analgesia is commonly used to close wounds, remove small growths and take biopsies in small animals. In large animals, infiltration analgesia may be used to perform laparotomies. These blocks are known as field blocks.



Regional Anaesthesia

Regional anaesthetic blocks will be discussed individually. The principle underlying these blocks is that nerve supply to a specific region or area is blocked where the nerves are easily accessible from the skin. The nerves may be readily palatable through the skin, and follow a fixed course next to easily identifiable anatomical structures (usually bones) or be known to be found at fixed positions. These blocks usually use a large volume of local anaesthetic as the needle is placed blindly and the large volume ensures that the local anaesthetic defuses to the nerve and induces the block. Sometimes these blocks are referred to as nerve blocks.



Inverted "L" block

The nerves supplying the abdominal wall start cranially at the spinal column and course ventrally and caudally to supply the abdominal wall. The inverted L block allows for the infiltration of local anaesthetic around this nerve supply to allow for abdominal surgery. Both the subcutaneous area as well as the deeper muscle layer needs to be infiltrated in order to provide adequate analgesia.

The inverted "L" block is simple technique that is easily applied. This technique is useful for laparotomies and caesarean's. It is important to remember that deep muscle layers and intra-abdominal sensation can still be present. Additional local anaesthetics can be applied during the surgery deeper muscle layers and peritoneal structures.

Spinal anesthesia

Spinal anaesthesia is the injection of local anaesthetic around the spinal cord. When local anaesthetics such as lidocaine or bupivacaine are used, all the segmental nerves (sensory and motor) which pass through the anaesthetic are paralyzed, although when opioids are used only sensory block (analgesia) occurs. Spinal anaesthesia is divided into two types; 'epidural' and 'true spinal'.

- Epidural (or extradural) anesthesia refers to depositing of local anesthetics into the extradural space. The needle enters the spinal canal, but does not penetrate the meninges. The anesthetic is therefore limited to the canal outside the dura mater.

- True spinal anesthesia refers to the subarachnoid access (usually known as 'spinal' anesthesia) in which the needle penetrates the dura mater, and the analgesic is injected into the cerebrospinal fluid (CSF).

The requirements from these techniques is paralysis of sensory nerves to the area in which

surgery is going to be performed. Muscle relaxation can be an added bonus or a disadvantage. Muscle relaxation of the limbs causes recumbency; and of the thoracic region limits respiratory movement. If local analgesic reaches the cervical region and affects the phrenic nerves, then respiration ceases! Thus most spinal and epidural anaesthesia is injected in the caudal regions of the animal, although there are several variations in terminology used, generally where injection of drugs in the coccygeal region and the dose of drug is such that the hind limbs are not affected, it is termed "caudal anaesthesia" where a higher dose of drug is given, still at the coccygeal area, so the hind limbs may be just affected, the term "epidural anaesthesia" is used, and where the block extends to the abdominal region, either because of the volume used, or because the injection is carried out at the lumbosacral space, the term used is "anterior epidural".

The autonomic effects of epidural anaesthesia can be quite profound. Many of the spinal nerves also carry fibers of the autonomic nervous system, which will also be blocked. The sympathetic fibers are responsible for vasomotor tone. Thus spinal and epidural anesthesia always causes hypotension; and if the block is sufficiently anterior to block the splanchnic outflow, this hypotension can be severe, even life threatening. Having an IV fluid line is essential prior to performing an epidural block to treat a potentially dangerous hypotension.

The area blocked by epidural anesthesia will depend on the site of injection.

- Common sites used in veterinary medicine (depending on the species) are the sacrococcygeal or intercoxygeal space, and the lumbosacral space.

- Quantity, volume of and specific local anesthetic injected.

- Size of the spinal canal. This varies not only between species of the same weight, but between breeds; with age; and with condition of the animal (e.g. fat / thin etc.).

- Position of animal (effects of gravity on spread).

- Removal of the anaesthetic from the canal. Again this depends on multiple factors, including age (influences size of "holes" in the dura around the nerves), condition, blood flow etc. The use of vasoconstrictors (epinephrine) will delay removal.

Thus epidural or spinal anaesthesia is not a very precise technique, and it is difficult to estimate the extent of the block which will occur, or its duration.

Complications of spinal and epidural block

- Infection – Apply good antiseptic practices (good clipping and scrubbing)

- Irritation causing spinal damage (most likely with subarachnoid). Avoid drugs with preservatives.

- Hind limb motor paralysis (problem in large animals, acceptable in small).

- Hypotension - most likely with a high block. Where this is being done fluid therapy or inotropes should be available to maintain blood pressure.

- Respiratory paralysis (only if massive overdose of local analgesic is used).l

Epidural Anaesthetic techniques

The “hanging drop” technique

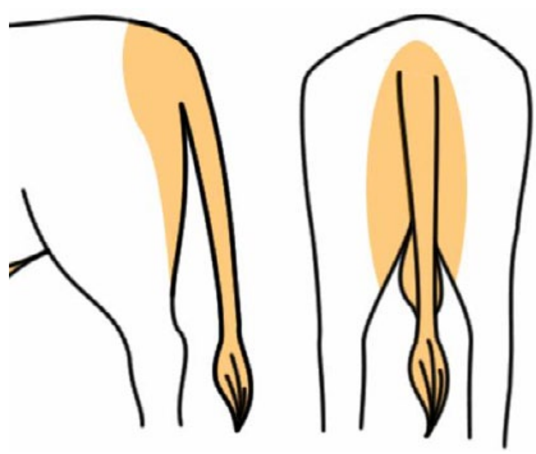
This involves removing the stylet of the spinal needle, filling the hub of the needle with saline or anesthetic solution, and allowing one drop to hang from the hub. As the needle is advanced through the ligamentous structures, the drop does not move. However, when the ligamentum flavum is penetrated the negative pressure in the epidural space will draw the drop of solution into the needle, indicating proper placement in the epidural space. A “pop” is often felt as the needle passes through the ligament. If the “hanging drop” technique fails, the “loss of resistance” technique can be used.

The “loss of resistance” technique

This indicates proper placement of the injection needle in the epidural space which is based on the amount of resistance to the injection of air or saline. When the epidural space is entered the injection of air, saline, or anesthetic solution will encounter minimal resistance. A separate syringe of normal saline or air (the same size should be used to ensure consistency) should be prepared. When minimal resistance to the saline or air injection is encountered, the saline syringe is replaced with a syringe-containing anaesthetic, and the injection is completed. To rule out the possibility of administering drugs into the venous sinus (presence of the blood) or subarachnoid space (presence of CSF), it is important to aspirate or allow a few seconds to check for bleeding before the epidural injection.

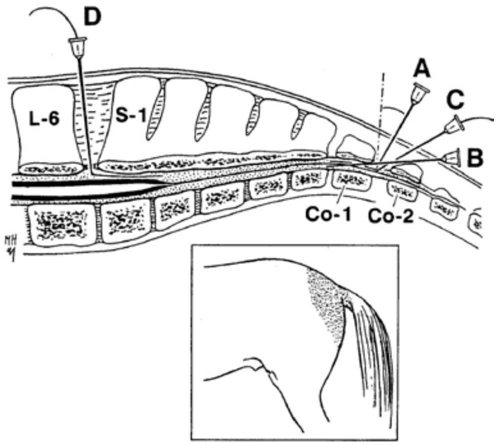
Epidural anaesthesia in bovines

In cattle, the spinal cord ends in the region of the last lumbar vertebra, but the meningeal sac goes to the 3rd / 4th sacral segments. For caudal and epidural anesthesia the injection site used is between coccygeal C1 and C2 (located by raising tail in “pump handle” fashion, the first obvious articulation behind the sacrum being C1 / C2). For a 500 kg bovine; 5 – 10 ml 2 % lidocaine will give caudal anaesthesia without causing hind limb ataxia or paralysis. Onset of paralysis of the tail should occur in 1 – 2 minutes. The block will last 1 – 2 hours. Larger doses will produce increasingly anterior effects.



If 100 to 150 mls of 2 % lidocaine is injected, the block will be sufficiently anterior to allow surgery of the hindlimbs, mammary tissue, flanks and abdominal wall. The bovine will be recumbent. Injection of local anaesthetics can be carried out at the lumbosacral junction in

order to produce an anterior block with less anaesthetic. Caudal anaesthesia is particularly useful for dystocias to stop straining and to provide analgesia for perineal structures. A high caudal block is required to perform abdominal surgery. Higher doses increase the risk that the cow will become recumbent. These blocks can also be useful in bulls for evaluation of testes and the penis. Entire analgesia to the penis is not provided with this block.

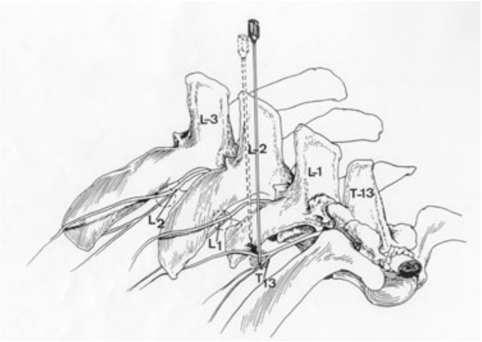


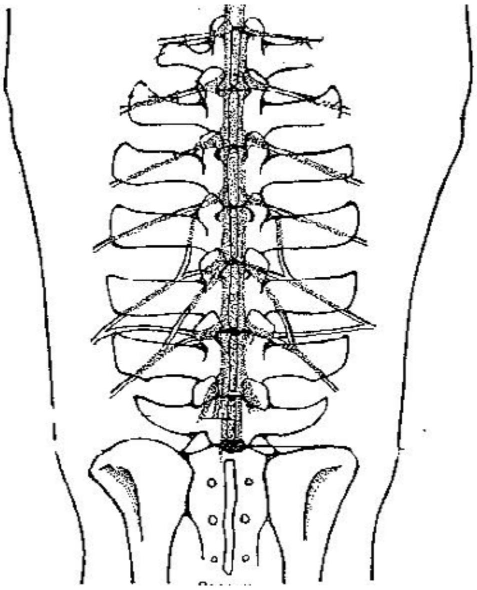
The technique may theoretically be carried out in any species, and at any level of the spinal cord but in practice, its main use is to provide anaesthesia of the lumbar region in ruminants. It's advantage is that it provides analgesia and muscle relaxation of the whole area covered by the segmental nerves blocked. Several different methods of achieving paravertebral anaesthesia have been described. All methods approaching from the dorsal surface are equally effective.

The method described whereby the needle is inserted ventral to the transverse processes of the spine has the disadvantage that the dorsal branches of the segmental nerves are not blocked, thus some skin sensitivity remains. Paravertebral anaesthesia is easy to carry out, and almost always effective, except in the very large beef breeds where it may be very difficult to locate the necessary landmarks.

Paravertebral anaesthesia

Paravertebral anaesthesia refers to the peri-neural injection of local anaesthesia about the spinal nerves as they emerge from the vertebral canal through the intervertebral foraminae.





Proximal paravertebral block

(Farquharson, Hall, or Cambridge Technique)
Indicated for standing laparotomy surgery such as C-section, rumenotomy, cecotomy, correction of gastrointestinal displacement, intestinal obstruction and volvulus. The dorsal aspect of the transverse processes of the last thoracic (T-13) and first and second lumbar (L-1 and L-2) vertebrae is the site for needle placement. The dorsal and ventral nerve roots of the last thoracic (T-13) and 1st and 2nd lumbar spinal nerves emerge from the intervertebral foramina are desensitized. 10 – 20 ml of 2 % lidocaine is injected to each site, onset occurs usually within 10 minutes of injection. Analgesia of the skin, scoliosis toward the desensitized side - due to paralysis of the paralysis of the paravertebral muscles, increased skin temperature due to vasodilation (paralysis of cutaneous vasomotor nerves) indicates effective block. Duration of analgesia lasts approximately 90 minutes.

Distal paravertebral block

(Magda, Cakala, or Cornell technique)
Indicated for same as proximal paravertebral block above. The dorsal and ventral rami of the spinal nerves T13, L1 and L2 are desensitized at the distal ends of L-1, L-2 and L-4. A 7.5-cm, 18-gauge needle is inserted ventral to the tips of the respective transverse processes in cows where approximately 10-20 ml of a 2 % lidocaine solution are injected in a fan-shaped infiltration pattern. The needle is completely withdrawn and reinserted dorsal to the transverse process, where the cutaneous branch of the dorsal rami is injected with about 5 ml of the analgesic. The procedure is repeated for the second and fourth lumbar transverse processes. 10 – 20 ml 2 % lidocaine is used per site and onset and duration similar to proximal technique.

Paravertebral block provides excellent analgesia for laparotomies provided that the anatomy is understood and the block is correctly applied. At least 15 – 20 minutes should be allowed for the block to become effective. Deeper muscle layers also effective blocked and visceral analgesia can be provided dependant on the nerve innervations.

NSAIDs

Non-steroidal anti-inflammatory drugs (NSAIDs) are one of the most used analgesic agents in the world in both human and veterinary medicine, These agents work through suppression of cyclo-oxygenase enzymes and prevent the production of inflammatory cytokines which result in pain, fever and inflammation. NSAIDs do not suppresses primary pain (pin prick) but do attenuate the secondary pain and peripheral hypersensitivity. Two iso-enzymes of the cyclo-oxygenase enzymes have been described namely COX-1 and COX-2. The COX-1 isoenzyme is considered to maintain normal physiological function while COX-2 isoenzymes are induced at time of inflammation or stress with in certain organ systems. NSAIDs that are COX-1 sparing or COX-2 specific are thought to produce less side effect. While this is partly true, both COX-1 and COX-2 enzymes are involved in inflammation and normal physiological function making this not as well delineated as we would like.

In terms of clinical efficacy, no conclusive evidence has yet been produced to show that one NSAID produces better clinical results than another. Evidence does exist to show that one NSAID can be better at suppressing inflammation or fever than another. These differences do not translate into a clinical efficacy difference.

NSAIDs are excreted in the milk after administration to lactating animals. This results in exposure of suckling animals to NSAIDs. Renal development is dependant on cyclo-oxygenase enzymes and inhibition of the enzymes can result in renal dysfunction. Most ruminants are born with almost fully functional kidneys and this is unlikely to be a major issue. All NSAIDs are hepatically metabolised and again liver function develops over the first few weeks of life. Ruminants are also born with functional livers and this is not a major issue. Current guidelines would suggest that a single dose of NSAIDs administered to lactating animals is unlikely to place undue risk to the suckling ruminant.

Cyclo-oxygenase enzymes play an important role in ovulation, ovarian function and foetal implantation. A trophoblastic protein is produced by the embryo to prevent uterine production of prostaglandin $F_2\alpha$ from inducing leuteolysis. NSAIDs suppress the production of prostaglandin $F_2\alpha$ and may enhance conception rates as a result.

The current choice of NSAIDs available in ruminants is limited by official label claims and clinical data. Phenylbutazone is justifiably banned in many countries and is no longer available for production animals. Available NSAIDs include meloxicam, flunixin and ketoprofen.

Following natural, assisted or cesarean delivery, at least two components of pain may be identified : postoperative (somatic) pain from the wound itself and visceral pain arising from the uterus. Although somatic pain may be relieved by opioids, NSAIDs may be effective for relieving visceral pain. NSAIDs provide little analgesia for primary acute pain (e.g. surgical incision) but do alleviate secondary pain, peripheral hypersensitivity and alter central processing of pain. Additional analgesia should be provided for painful procedures and surgery.

The use of NSAIDs should not impact on the performance of herd. In dairy cattle this would for example be reproductive indices and milk yield. Meloxicam did not interfere with reproductive performance, body weight or calf vitality when administered before breeding, after breeding,or at the beginning of the second and third trimester. Flunixin and carprofen have been shown not to influence conception rates.

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Notes

Alice Barrier

Alice Barrier graduated from Agrocampus-Ouest (France). She studied life sciences, agricultural sciences, and undertook her MSc with a focus on animal sciences, particularly dairy sciences. She has developed an interest in animal welfare through her research experiences in Canada, France and the United Kingdom where she has worked on welfare issues affecting dairy cows and calves. She joined SAC in 2008 to undertake a PhD, during which she studied how calving difficulty affects the production, health and welfare of the dairy cow and the detrimental consequences it has on their calves. As part of her PhD, she became interested in the problematic of pain at parturition and studied potential behavioural indicators of pain around calving. Alice is working as a postdoctoral researcher at SAC since October 2011. Alongside some teaching and student supervision activities, she works on a project on welfare assessment protocols in dairy cattle and, in partnership with Boehringer Ingelheim, on pain after a caesarean section.

Dr. Cathy Dwyer, BSc, PhD

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

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

Pain and discomfort associated with caesarean section in cattle

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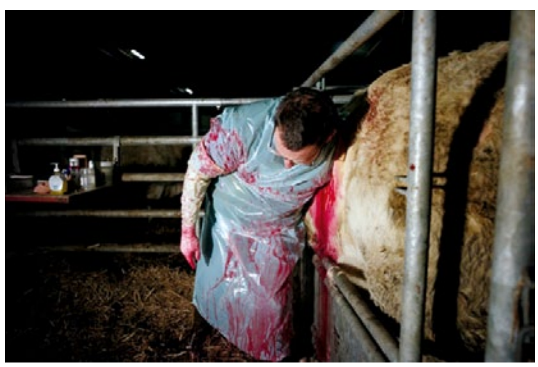
Pain at parturition and following a caesarean section

Caesarean sections are a commonly performed surgical procedure in cattle. Sections are carried out in approximately 1 to 2 % of calvings (Patterson et al., 1981; Barkema et al. 1992a) and usually follow severe calving difficulty (dystocia), when the calf can not be safely delivered vaginally. Although caesarean sections are mostly non-elective emergency surgeries, in some breeds like the Belgian Blue, elective sections have become the norm to deliver the calves due to the discrepancy between the dam's pelvic size and the size of the offspring. Elective or not, such surgical operations remain intrinsically risky for both cows and calves, particularly when they are performed in agricultural settings where lack of asepsis can be an issue. Surgical complications during or following a caesarean include cow recumbency, haemorrhages, tears, adhesions, peritonitis, and infections (Kolkman et al. 2009; Newman 2008). Ultimately, such surgery can affect the reproductive tract (e.g., metritis, retained placenta), impaired fertility, lowered milk production, premature cull and death of the cow and or calf (Barkema et al. 1992b; Tenhagen et al. 2007), with implications on the productivity and welfare of the cow and her calf(-ves).

During labour, cows are likely to incur both somatic and visceral pain (Brownridge, 1995; Mainau and Manteca, 2011). Across various countries, dystocia is recognised by veterinarians as being a very painful condition (Huxley and Whay, 2006; Laven et al. 2009; Kielland et al., 2009; Fajt et al. 2011). Behavioural changes observed in labouring cows when dystocia occurs may indeed reflect higher levels of pain than cows calving without difficulty (Barrier et al. 2012a). Postpartum pain may also be present in the reproductive tract as a result of pressure, stretching and likely associated injuries (such as tears, lacerations or hematomas) in the birth canal (Scott, 2005; Barrier et al. 2012b). Yet, pain resulting from giving birth has received little attention in farm animals and is poorly understood in cattle (Rushen et al. 2007; Mainau and Manteca, 2011; Barrier et al. 2012a).



Following a caesarean section, cows would experience postsurgical pain as a result of cutting of the skin, muscle and other tissues, causing acute somatic pain at the site of injury, which is sharp, stinging and highly localised. Visceral pain would occur because of manipulations of the uterus and other viscera, their distension, traction necessary to extract the foetus from the cow's abdominal cavity. This follows inflammation of the tissues and is reported as being more diffuse, dull and poorly localised. As well, there may also be underlying postpartum pain in the reproductive tract in patients that undergo emergency C-sections. This could be due to failed attempts at a vaginal delivery and additional pressure exerted when trial manual extractions may have taken place.

Assessing pain and discomfort associated with C-section in cattle

There is a growing interest in the alleviation of parturition pain in cattle associated with dystocia and whether this can be achieved through the use of non-steroidal anti-inflammatory drugs (e.g., Duffield and Newby, 2010; Mainau Brunsó, 2011). However, this requires identification of best indicators of pain at parturition in cattle.

Studies focusing on parturition prior to delivery of the calf have identified a variety of behaviours as likely indicators of greater pain and discomfort when calving difficulty occurs. These include higher levels of rubbing, scrapping and urine discharge (Wehrend et al. 2006), higher level of tail raising, restlessness and time spent lying completely flat (Barrier et al. 2012a); self-grooming, kicking and head-turning (Mainau et al. 2010); and increased number of postural transitions (Proudfoot et al. 2009). A comparison of Belgian blue cows calving through the vaginal route or whose calf was electively delivered by a caesarean section (without provision of postoperative analgesia) highlighted longer time spent lying and increased postural transitions after surgery (Kolkmann et al. 2010). Looking at the postpartum period, primiparous dairy cows that had received meloxicam (a Non Steroidal Anti-Inflammatory Drug or NSAID) shortly after calving were more active in the first week than cows receiving a placebo, as assessed by the number of steps taken (Mainau Brunsó, 2011). Altogether, it suggests that activity-related behavioural changes may be suitable behavioural indicators to investigate pain in the periparturient animal.

Management of perioperative pain with the use of NSAIDs

In farm animals, although administration of pain relief is provided during surgery including caesareans sections (Huxley and Whay, 2006; Hewson et al. 2007), there has typically been fewer concern about mitigation of pain once the surgical procedure is over (Chevalier et al., 2004; Hewson et al. 2006; Walker et al. 2011). This is despite the knowledge from human medicine that inadequate treatment of post-operative pain is associated with longer time needed for recovery (Pyati and Gan, 2007). To date, there are, however, no drugs licensed for use in cattle

to specifically alleviate pain experienced following a caesarean section.

According to a recent survey across three European countries, only 13.8% of the veterinarians establish post-surgical analgesia after bovine caesarean section, mostly through the use of NSAIDs (Hanzen et al. 2011). NSAIDs are successfully used for pain relief after a caesarean section in human obstetrics (Olofsson et al. 2000; Angle and Walsh, 2001). There should also be adequate choices to provide for postoperative analgesia in cattle, by using flunixin or ketoprofen (Newman, 2008), or meloxicam.

Administration of meloxicam, a NSAID of the oxicam class could reduce inflammation and pain associated with parturition and surgery. It acts by inhibition of the cyclooxygenase, COX2, involved in the synthesis pathways of prostaglandins responsible for pain and inflammation, providing a long lasting anti-inflammatory and analgesic effect (EMEA, 2012). In cattle, its half-life of about 26h makes it a suitable candidate for alleviating pain after a C-section. Indeed, research has indicated that most of the pain would occur during that time frame (Kolkmann et al., 2010) and, in practice, it means it would require a single administration of the drug at surgery. In cattle, this NSAID has been found effective in the treatment of calves with neonatal diarrhea complex (Todd et al. 2010) and in decreasing post-surgical pain following dehorning (Heinrich et al. 2010). In other species, it is licensed for alleviating visceral pain associated with colic in horses and to provide for postoperative analgesia after abdominal surgeries in cats, dogs and rats (e.g., Caulkett et al., 2003; Gassel et al. 2005; Roughan and Flecknell, 2006).

It is therefore expected that through its anti-inflammatory properties, a NSAID such as meloxicam might be an adequate drug in reducing somatic and visceral pain that are likely to arise after a non-elective caesarean section.

Theory in practice: in-field trial of the use of meloxicam to address pain and discomfort following a non-elective caesarean section in beef cattle

Boehringer Ingelheim Animal Health is investigating if pre-emptive administration of meloxicam (a long-acting NSAID drug) at start of surgery could mitigate postpartum pain and discomfort associated with a caesarean section in beef cows. Activity-related behavioural changes have been identified as suitable candidates to study postsurgical pain.

110 beef cows (55 primiparous, 55 multiparous) that underwent non-elective standardised caesarean section were recruited from 8 French veterinary practices (investigators). Surgery took place under local anaesthesia, achieved with a line block of lidocaine hydrochloride. Cows received pre-emptively either meloxicam (Metacam® 20 mg / ml, 0.5 mg / kg bodyweight) ($n = 63$) or a placebo ($n = 47$) according to a blind randomised schedule. Pedometers (IceTag3D, IceRobotics Ltd, South Queensferry, UK) were

attached to each cow's hindleg and the cow's activity was monitored from 0 h (end of surgery) to 68 h postpartum. Percent of time spent lying, number of steps, MotionIndexTM and counts of lying bouts were investigated in the first 68 h postpartum.

It appeared that cows that had received meloxicam lay down for longer and had more bouts of lying in the first 24 h compared to cows receiving a placebo. It is commonly considered that such behavioural changes in cattle are indicative of pain (e.g., Anderson and Muir, 2005; Kolkman et al., 2010; Walker et al. 2011). In this study, this assumption is however unlikely. The relationship between resting, pain and discomfort at parturition needs to be better understood.

This work has highlighted the particular difficulties in assessing pain in parturient animals. Parturition is intimately intertwined with a variety of physiological, behavioural and environmental challenges that each influences the behaviour of the cow. Recovery, possible motivation to rest after the experience of labour, having to care for a newborn calf, metabolic strain of lactation, possible adaptation to new environments, are some of the examples that make the context of the postpartum pain distinctive to other contexts where pain has been the focus of studies.

As recently emphasised in reviews on pain at parturition (Mainau and Manteca, 2011) and surgical pain in farm animals (Walker et al., 2011), this work highlights that such issues ought to deserve more attention than they currently receive. Tackling the issue of parturient pain (operative or not) in cattle requires the development of validated pain measurements applicable to the parturient animal.

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Todd graduated from the Ontario Veterinary College (OVC), University of Guelph 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 100 peer-reviewed articles on several aspects of dairy health management including transition cow metabolic disease, use of monensin in dairy cattle, production limiting diseases (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.

Use of NSAIDs around calving

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Abstract

While it is very likely that there are many positive benefits of treating dairy cows postcalving with NSAIDs (especially cows that experience a dystocia), an important question is the timing of administration postcalving. Based on current thinking on alleviation of pain and inflammation, treatment postcalving should be instituted as soon as possible. There is, however, concerns with retention of fetal membranes, although the current literature on NSAID treatment postcalving and risk of retained placenta (RP) is mixed.

Introduction

Parturition is a necessary event for production that happens every day on dairy farms across the world. Parturition is an inflammatory event marked biochemically by elevations in acute phase proteins postcalving (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. 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 NA (> 10 %) compared with other parts of the world (< 5 %) and regardless of country are much higher in primiparous animals (Mee 2008). 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 may correspond to a decrease in milk production. Non-steroidal anti-inflammatory drugs may play a therapeutic role in alleviation of the impacts of this inflammation and presumed pain associated with the event of parturition.

Analgesia at Parturition

There is limited work published on the impact of analgesia at calving in dairy cows. An older study has shown that consumption of the amniotic fluid by the cow provides some analgesic effect (Machado et al. 1997) and this effect of amniotic fluid has also been documented in rats (Kristal et al. 1990). Under our current management conditions, it is better for calf health if the calves are removed from their dams immediately after birth. As a result of these recommendations, many dairy cattle may not get the benefit of ingestion of amniotic fluid. 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.

NSAID Use at Parturition

Flunixin meglumine

Two studies in periparturient dairy cows have been conducted with treatment of dairy cows at calving with flunixin meglumine. In one study, flunixin meglumine was administered at a dose of 2.2 mg / kg intravenous daily for the first three days of lactation beginning at parturition (Shwartz et al. 2009). Flunixin meglumine increased rectal temperature for the first seven days of lactation, decreased DMI by over 2.0 kg per day and had no impact on milk yield for the first 35 days in milk (Shwartz et al. 2009). In another study, flunixin meglumine was administered intravenously at a fixed volume of 22 or 25 mL (50 mg / mL, providing the label dose range of 1.1 to 2.2 mg / kg BW) within 1 hour and again 24 hours after calving (Duffield et al. 2009). This study was conducted in 1174 cows on one large farm in Michigan and in 148 cows at a research dairy facility near Guelph. Results showed a significant increase in both the risk of retained placenta (OR = 2.5, $P < 0.001$) and the risk of metritis (OR = 1.5, $P < 0.001$) (Duffield et al. 2009). There was no difference in milk production, serum metabolic parameters or acute phase proteins between treatment groups in this study. The results of this study appear consistent with that of Waelchi et al. 1999, who reported a 3 times increased risk of RP in cows treated with flunixin meglumine compared to saline control at the time of caesarean section. The most likely explanation for these findings would be a tocoyltic effect for flunixin meglumine interfering with myometrial contractions and responsiveness to oxytocin through anti-prostaglandin actions (Thun et al. 1993). As a result, flunixin meglumine cannot be recommended for pain alleviation in cows on the day of calving.

Ketoprofen

One large study exists in the peer-reviewed literature on ketoprofen at calving. In this study, 220 cows and heifers were given ketoprofen at 3 mg / kg BW immediately after calving and 24 hours later (Richards et al. 2009). A total of 227 animals served as untreated controls. Animals treated with ketoprofen were 1.7 times less likely to incur an RP compared to the untreated cows. There was no impact on other measures of uterine or reproductive health and no effect of ketoprofen treatment on milk yield.

Meloxicam

At least three studies involving meloxicam and cows at parturition have been conducted but not have yet been published in the peer reviewed literature.

In the first study (Manteca et al. 2010) a total of 30 heifers and 30 cows were enrolled on a commercial dairy farm in Spain. Treatment (meloxicam at 0.5 mg / kg BW SQ or equivalent placebo) assignment was randomized and administered within 12 hours of calving in animals that were either unassisted or had an easy manual assisted delivery. No effect of treatment was identified for milk yield. The activity of heifers given meloxicam was greater than that of placebo animals in the days after calving.

The second study was conducted in 100 assisted calvings at the dairy research facilities near Guelph, ON, Canada. Treatment assignment was randomly assigned within parity (1 and > 1) so that animals received either meloxicam at 0.5 mg / kg BW SQ or equivalent volume placebo SQ. Treatment was administered after the first 24 hours following calving. Preliminary results from this study indicate no difference between treatments on DMI, milk production, or metabolic health. However, meloxicam treated cows had both more frequent visits to the feedbunk and a longer duration of feedbunk visits (Nathalie Newby, personal communications).

The third study involved enrolling cows and first parity heifers on the day of calving with either meloxicam at 0.5 mg / kg BW SQ or be assigned as an untreated control animal at a large commercial dairy farm near London, ON, Canada. This study Involved 462 cows (235 receiving meloxicam, 227 untreated controls). There was no effect of treatment on milk production and no impact of treatment on the risk of retained placenta (OR = 0.87, P = 0.67).

A fourth study involves investigation of the potential benefits to treating newborn calves with meloxicam. A total of 842 calves were randomly assigned to either meloxicam (0.5 mg / kg BW SQ) or equivalent placebo volume at birth. Preliminary data analysis indicates improved health scores over the first six weeks of life in calves receiving meloxicam (Christine Murray, personal communications).

Summary

Based on the studies reported above, it can be concluded that short-term treatment of cows at calving with NSAIDs is unlikely to have any impact on milk yield. Given the strong homeorhetic drive for dairy cows to produce milk, this is perhaps not surprising. There may be some behavioural benefits to NSAID treatment around calving, as indicated through changes in feeding behaviour and activity in two studies with meloxicam. There is a very real risk of increased incidence of retained placenta in animals treated with flunixin meglumine on the day of calving. This risk does not appear to be present for either meloxicam or ketoprofen. There may be benefit for treating some calves following birth with NSAIDs.

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