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Feeding management of transitional cows

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Abstract
The term transition is to underscore the important physiological, metabolic, and nutritional changes occurring in this time frame. Over the past 15 years, the dry cow and especially the transition period have been recognized as critical elements to improving dairy productive and reproductive efficiency. Numerous research studies completed over this time period have better explained dynamic metabolic and physiologic changes taking place as a cow transitions from pregnancy into lactation and their potential role in health-related problems. Improved characterization of nutrient requirements and management practices has also been elucidated. Besides the obvious impact on periparturient disease, transition nutrition influences milk production and reproductive performance. Transition nutrition is not the sole solution, it must be coordinated with good cow comfort, feeding management and methods to reduce behavioral and environmental stressors.

Keywords: Dairy cows, nutrition, transition period

Introduction
The transition period in dairy cows is defined as the last three weeks before parturition to three weeks after parturition (Grummer, 1995) [1]. It constitutes a turning point in the productive cycle of the cow from one lactation to the next. It is characterized by tremendous metabolic and endocrine adjustments that the cows must experience from late gestation to early lactation (Drackley *et al*., 2001) [2]. Perhaps the most important physiological change occurring during this period is the decrease in dry matter intake (DMI) around parturition and the sudden increase in nutrients that cows need for milk production (Drackley, 1999 [3]; Ingvartsen and Andersen 2000) [4]. The importance of a successful transition from late pregnancy to early lactation is well accepted. Health problems during the transition period can easily erase the entire profit potential for an individual cow in that lactation, through increased costs for veterinary treatment and lost production potential (Drackley, 1999) [3]. Nutrition not only has a direct effect on reproductive performance, but can influence reproductive potential through its mediation of periparturient disease prevalence. Management practices focused to ensure good health or prevent serious postpartum disease conditions are also important in managing reproductive performance. Reproductive performance of dairy cattle needs to be approached on a herd basis.

Physiological and metabolic changes during the transition period
Dry matter intake
Dry matter intake starts to decrease a few weeks before parturition with the lowest level occurring at calving (Ingvartsen and Andersen, 2000) [4]. Average values for the prefresh transition period have been reported to range between 1.7 and 2.0% of body weight (BW) (Hayirli *et al*., 1999) [5]. However this is not a constant value and it can be influenced by the ration that is fed (concentration of nutrients), the stage of the transition period, body condition score (BCS) and parity (Hayirli *et al*., 2002) [6]. Dry matter intake decreases about 32% during the final three weeks of gestation, and 89% of that decline occurs at five to seven days before calving (Hayirli *et al*., 2002) [6]. As a percentage of body weight, heifers consume less feed than cows at 21 days before calving.

Endocrine and metabolic changes
Alterations in neuroendocrine function in response to a stressor affect nearly all functions of animal production, including metabolism, reproduction, lactation, immune competence,

and behavior. These alterations include not only the classic neuroendocrine response to stress, but also may include changes in the pituitary secretion of prolactin, growth hormone, thyroid-stimulating hormone, and the gonadotropins (Moberg, 2000) [7]. Endocrine and metabolic changes in transition dairy cows are affected by prepartum infusions of a serotonin precursor. Serotonin (5-HT) has been shown to be involved in calcium homeostasis, modulating calcium concentration in blood. In addition, 5-HT participates in a variety of metabolic pathways, mainly through the modulation of glucose and lipid metabolism. The prepartum administration of 5-hydroxy-l-tryptophan (5-HTP), a 5-HT precursor, would affect endocrine systems related to calcium homeostasis, and interact with other endocrine and metabolic pathways during the transition period.

Glucose and lipid metabolism

Glucose and amino acids are the major fuel supply of the developing foetus in ruminants. Glucose and amino acids are also needed by the mammary gland for lactose and milk protein synthesis, respectively (Horst *et al*., 1997) [8]. Ruminants are not entirely dependent on dietary glucose; as a result they are in a constant stage of gluconeogenesis (Drackley *et al*., 2001) [2]. The major gluconeogenic precursor in ruminants is propionic acid produced in the rumen. Its contribution to gluconeogenesis has been estimated to be 32 to 73% (Seal and Reynolds, 1993) [9]. Liver uptake of propionate by portal circulation is almost 100% (Bines and Morant, 1983) [10]; however the capacity of the liver to convert propionate to glucose seems to be responsive to the amount of propionate supplied and the physiological stage of the animal (Drackley *et al*., 2001) [2]. Hepatic propionate metabolism is modulated during the transition period. As an example, hepatic blood flow in cows increases 84% from 11 d prepartum to 11 d postpartum (Reynolds *et al*., 2003) [11]. In addition, propionate conversion to glucose by the liver is 19 and 29% greater at day 1 and 21 postpartum, respectively, than at day 21 prepartum (Overton *et al*., 1998) [12].

Periparturient disease and reproduction

Veterinarians recognize the critical nature of the transition period as it relates to periparturient disease. Periparturient diseases are the scourge of the dairy industry. Total financial losses associated with periparturient diseases result from lost and discarded milk, veterinary fees, increased labor, pharmaceuticals and premature culling. Reproductive performance is also adversely affected by periparturient disease. Conception rate(CR) for cows that have experienced at least one periparturient disease incident is 35% lower as compared to cows with a disease-free calving (Reynolds *et al*., 2003) [11].

Milk Fever, Parturient Paresis, Hypocalcaemia

Milk fever is a non-febrile metabolic disease affecting milking cows in which acute calcium deficiency causes progressive neuromuscular dysfunction with flaccid paralysis, circulatory collapse, and depression of consciousness (Oetzel and Goff, 1999) [13].

Ketosis and Fatty Liver

Ketosis is defined as a metabolic disease characterized by high levels of ketone bodies affecting cattle, sheep and goats. Ketosis affects dairy cows in the period from parturition to 6 weeks postpartum (Herdt and Gerloff, 1999) [14]. There are two types of ketosis, primary and secondary. Cattle with primary clinical ketosis have a decreased appetite and elevated serum, milk, urine or breathe ketones in the absence of another concurrent disease (Kelton *et al*., 1998) [15].

Retained Foetal Membranes - Metritis Complex

Retained Foetal Membranes is defined as the lack of detachment of foetal membranes from the maternal caruncles within the first 12 to 24 hours after calving (Grunert, 1986 [16]; Eiler, 1997) [17]. Retained foetal membranes have been the major factor that predisposes cattle to metritis.

Abomasal Disorders

Displacements, dilatations, and volvulus of the abomasum are the most commonly encountered disorders of the gastrointestinal tract in modern dairy operations (Trent, 1990) [18]. Displacement can be on the left side (LDA) or the right side (RDA) (Fecteau *et al*., 1999) [19]. Omental attachments of the abomasum prevent true torsion around the long axis of the abomasum, with rotation occurring around an axis through the supporting lesser omentum. Therefore, a more accurate term for the syndrome is “abomasal volvulus”, rather than torsion. Any right-sided displacement that requires further manipulation to free the pylorus and duodenum may be considered for practical purposes to be a volvulus (Trent, 1990) [18].

Feeding management of transition cow

Feeding a cow during the transition period is a challenge due to the nutritional and physiological changes that occur during this period (Grummer, 1999) [20]. To increase the potential for successful reproduction and prevent periparturient diseases, following are the critical control points during transition period that need to be addressed:

1. Maximizing dry matter intake

Cows that experienced periparturient disease have shown that there was a greater decline in dry matter intake. Restricting DMI in the dry period allows cows to increase DMI immediately postpartum, resulting in higher energy balances, and decreased body fat mobilization, evident by lower NEFA (non-esterified fatty acid) and BHBA (beta hydroxyl butyrate) concentrations (Dann *et al*., 2006) [21].

2. Maintaining lactation ration

Feeding higher-fibre concentrates which enable higher intakes, reduce milk yield compared to higher starch rations. A practical approach for maintaining energy intake in late gestation is to provide limited amounts of lactation ration to ‘close-up’ cows, and remove straw from their ration. The higher energy concentration of the lactation ration compensates for any reduction in intake, adaptation of the rumen is allowed, and fill of indigestible fibre is reduced, enabling more rapid rumen turnover and greater intake after calving.

3. Stimulating rumen papillae development

Rumen papillae helps to maintain acid-base balance in the rumen by absorbing volatile fatty acids and especially lactate, generated by microbial fermentation. Growth of these papillae is influenced by the presence of fermentation products, primarily propionate and butyrate and not acetate. Higher fibre diets predominately produce acetate during fermentation, which results in a reduction in papillae length.

Adding fermentable non-structural carbohydrates to the late gestation diet can have positive effects by initiating rumen papillae growth and allowing rumen organisms to adapt to the starch substrate. Adapted rumen papillae to grain diet during a prepartum helps to facilitate the transition to a high grain diet during post lactation stage. This would potentially allow the cow to increase DMI more rapidly postpartum and minimize the disease problems associated with ruminal acidosis and displaced abomasum (Andersen *et al*., 1999) [22].

4. Maintaining calcium homeostasis

The onset of lactation causes a severe and rapid drain on blood calcium required to produce milk. If this blood calcium is not replaced as rapidly as it is reduced via bone calcium release (resorption) or intestinal absorption of calcium, cows will become hypocalcaemia with some developing clinical milk fever. Reducing DCAD (dietary cation-anion difference) to negative values has been shown by many authors to prevent this rapid decline in blood calcium at calving. DCAD should be less than zero postpartum (-10 to -15 meq/100 g dry matter if forages are variable in potassium levels).

5. Minimizing negative energy and protein balance

Excessive energy intake leads to 'fat cow syndrome'. Feeding gluconeogenic precursors such as propylene glycol has also shown positive effects on energy status of the late pregnant cow. Prepartum protein depletion adversely affects periparturient metabolic status, resulting in a greater incidence of ketosis and fat cow syndrome. Energy balance of a transition cow is determined by subtracting energy requirements for maintenance and gestation from energy intake. During the transition period, feed intake is decreasing at a time when energy requirements are increasing due to growth of the conceptus. Consequently, to maintain the energy balance the energy density of the diet should increase (Grummer, 1999) [20]. Feeding higher protein during the transition period reduced feed intake or milk yield postpartum (Donkin *et al*., 1998) [23].

6. Minimizing immune dysfunction

The immune system of the cow has been shown to decline in response to the transition period, possibly as a result of increased cortisol secretion associated with stress of late gestation and calving. Neutrophils are a type of white blood cell involved in the first line of defence against infection (Frandson *et al*., 2006) [24]. It has been reported that the function of neutrophils is impaired in transition dairy cows leading to a state of immunosuppression. Elevated blood NEFA concentrations before calving have been linked with uterine disorders and impaired neutrophil function (Hammon *et al*., 2006) [25]. Therefore, the metabolic demands of lactation can affect the cow's ability to recover from immunosuppression (Kehrli *et al*., 2006) [26]. Micro minerals and vitamins supplementation recover from immune function problem.

Conclusion

Transition period is the most important period during which considerable metabolic adjustment occurs in dairy animals. Sub-optimal nutrition during this time period may impart nutritional stress on the cows leads to many periparturient disorders. Attention must be given to formulating appropriate diets for cows during this period.

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