Pre-Weaning and Post-Weaning Nutrition

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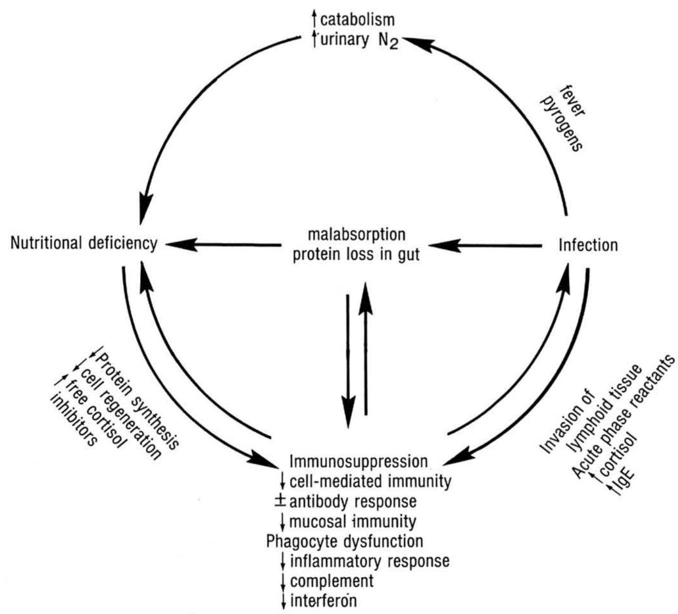
A successful preconditioning program requires a total commitment to proper health, nutrition, and management practices. It cannot be said that any one of these factors is more important than the other two because the effectiveness of each depends on the proper implementation of all. If these practices are not properly implemented, the preconditioning concept will not be profitable for either the cow:calf producer or the cattle feeder.

Preconditioning programs which have failed are usually associated with high morbidity and mortality and/or poor average daily gain and feed conversion. Nutrition plays an important part in maintaining each of these areas.

Nutrition and Health

The relationship between proper nutrition and disease has been reported for centuries in humans and laboratory animals. Only recently has this area been addressed with the stressed calf and there is only limited data available. However, the interaction in the calf is expected to be basically the same as that in humans because of the similarities which exist in the immune system. It has long been observed that under-nutrition predisposes the host to the risk of disease and that the severity and mortality rates are greatly increased. This is most likely due to decreased immunocompetence secondary to the nutritional deficiency, according to Chandra/Newberne (1977). It is known that nutrients influence both the intra- and extra-cellular biochemical environment, thereby influencing the immune response. However, over-nutrition as well as under-nutrition, can alter the rumen response. Therefore, a balanced nutritional program, along with proper herd management, can reduce the incidence and severity of disease. Chandra/Newberne (1977) described the mechanism of interaction between infection, nutritional deficiency, and immunosuppression as follows:



This diagram shows that nutritional deficiency predisposes the host to the risk of acquired infection and that the **infection may reduce the nutritional status** by causing malabsorption and protein loss through the gut.

Many of the studies conducted to determine the effect of nutrition on disease have involved malnutrition, especially in the area of protein or individual amino acid deficiencies.

Substances involved in the immune response, such as globulins, lysozymes, basic polypeptides, interferons, and properidins are composed primarily of protein. Various vitamins and minerals are also required for their synthesis. Thus, a nutritional deficiency could reduce the body's content of these immunological substances, thereby reducing the animal's resistance to disease.

Energy malnutrition has also been associated with reduced disease resistance. However, it is thought that protein can be broken down to meet the energy requirement. This reduces the available protein for maintenance of the immune response.

A deficiency in vitamin A has been associated with degradation of epithelial tissue. This breakdown reduces the protective barrier to invading microorganisms, thereby allowing easier access into the body.

Other studies have shown that deficiencies of the B complex vitamins, vitamin C, vitamin E, and certain mineral elements also reduce the animal's resistance to invading infections.

Research has also been conducted on animals that have been fasted or where feed intake was limited, simulating a common situation in calves when they are weaned and shipped to their feeding destination. Studies demonstrate that fasting reduces the immune response and thus, increases susceptibility to disease. Both situations, malnutrition and fasting, appear to be more important in reducing resistance to bacterial disease than those caused by viruses.

Stress and Rumen Environment

The ruminant animal is unique in that many of the nutrients supplied in the feed are not the ones utilized at the tissue level. In order to utilize these nutrients, they go through a fermentation phase by the microorganisms in the rumen where they are converted into compounds that can be used at the tissue level. The rumen of a healthy animal contains millions of bacteria and protozoa. However, animals which have been stressed because of weaning, handling, new surroundings, etc., will tend to backoff feed and have a reduced number of bacteria and protozoa, thus reducing the nutrients supplied to the tissue for proper animal growth, development, and disease resistance.

Baldwin (1967) reported on a number of studies concerning the fermentation capacity of the rumen after 48-hour fasting. Baldwin noted the following:

1. An almost complete lack of rumen protozoa.
2. A reduction in rumen bacteria to 10-25% of normal.
3. The surviving bacteria represent only a few of the many types of bacteria ordinarily present.
4. The capacity of rumen bacteria to ferment added sugar is reduced to 10% of normal after 24 hours of starvation.
5. The fermentation activity is reduced to zero after 48 hours of starvation.

This research is supported by that of Hamlett et al. (1982), where they observed a 25.6% decrease in rumen liquid volume, a 71% decrease in gas producing potential, a 25% decrease in rumen total VFA concentration, and a 50% decrease in rumen protozoal concentration after cattle had been held at an auction barn without feed for 24 hours.

Because of the rapid changes that occur in the rumen, it is important that the calves be free of stress at the time of weaning and have been on the proper nutritional program to ensure that all metabolic functions are operating at peak efficiency. It is important to remember that not only are we trying to maintain or increase the resistance to disease by preconditioning, but also increase weight gain in order for the concept to be profitable to the cow:calf producer.

Nutritional Requirements of the Stressed Calf

The nutritional requirement of the stressed calf is different from that of a normal calf because of the changes in rumen environment, loss of body fluids, and the reduced feed intake which occurs during the first week following weaning or transportation.

Much of the nutritional research with the stressed calf has been conducted with new feedlot arrivals. The weaned calf undergoing a preconditioning program has not been subjected to as much stress as most new feedlot arrivals; however, the authors of this paper feel their nutritional requirements are similar and the data summarized in this report will reflect this thinking.

Protein

The limited data available suggest the protein requirement of calves undergoing preconditioning is between 13.5 and 15.5% of the ration dry matter. The higher level being the requirement for calves weighing less than 350 lbs. The higher requirement is due to the reduced feed intake of the lighter, younger calf.

Research conducted by Cole and Hutcheson (1982) showed a small increase in average daily gain (.22 lbs) and a reduction in death loss (15 vs 8%) when the protein level of the ration was increased from 12 to 16%. Ralston Purina (1972, 1978) has conducted 2 trials where rations containing either 13.5 or 15.5% protein were evaluated. These trials did not produce any differences in average daily gain, feed intake, morbidity or mortality. The combined results of these studies would suggest that the response obtained by Cole and Hutcheson (1982) occurred approximately midway in the range they evaluated. This is supported by the work of Embry (1977), where he noted an improvement in performance by increasing the ration protein level from approximately 10.0% up to 13.4%. No further improvements in the performance were noted with level of protein higher than 13.4%.

The addition of urea to the ration of a stressed calf may be important. The urea provides a readily available nitrogen source which is required for the bacterial and protozoal repopulation of the rumen. This hypothesis is supported by the data of Cole and Hutcheson (1982), which suggests that a ruminal ammonia deficiency can occur following a period without feed or water. Gates and Embry (1975) evaluated the feeding of 4 lbs/hd/day of 32% protein supplements containing either soybean meal, soybean meal plus urea (12% protein equivalent from non-protein nitrogen) or one containing 24% protein equivalent from non-protein nitrogen with full feed corn silage. Performance was slightly superior during the first fourteen days with calves on the high urea supplement vs either the all soybean meal supplement or the low urea supplement. However, by the end of the 28-day period, performance was similar on the soybean meal and the low urea supplement, whereas, calves fed the high urea supplement showed a reduction in daily gain of approximately 21.6% with a 15% poorer feed conversion. Phillips and McLaren (1981) showed that urea could replace up to 20% of the total ration nitrogen when corn gluten meal was used as a protein source.

These data suggest that urea can be used to supply a portion of the supplemental protein; however, high levels should be avoided. This has been documented not only in the work of Embry (1977), but also in that of Byers and Smith (1976) and Preston et al. (1975).

Ralston Purina recommends that a maximum of 2.2% of the ration protein be supplied in the form of urea.

There has been some interest in the use of a rumen by-pass protein source for the stressed calf. The Phillips and

McLaren (1981) study also evaluated the value of a solely degradable protein source (corn gluten meal). Performance was similar between this and a soybean meal-containing ration. These results are similar to those found by Axe et al. (1982), when they compared a ration containing a combination of blood meal, corn gluten meal, and brewers grains to one containing cottonseed meal. However, when they increased the levels of these sources to produce a 16 or 20% protein ration vs the control at 14%, they did note an improvement in performance. This improvement in performance was probably due to the lightweight calves (244 lbs) used in this study.

Energy

Rations used in preconditioning programs have varied from all roughage to those containing up to 90% concentrate.

All Roughage

Advantage	- Eliminates concern for rumen malfunction problems
Disadvantage	- Poor animal performance. Rumen environment is below optimum.

High Concentrate

Advantage	- In some situations, will promote maximum animal performance and disease resistance.
Disadvantage	- Can produce remen malfunction problems with overconsumption, thereby causing poor performance and lower disease resistance.

Totusek and Stephens (1969) conducted a study in which they compared a high concentrate, an all roughage, and a 35% concentrate ration. Calves fed the high concentrate ration went on feed quickly and incurred rumen malfunction and health problems, whereas, those fed the 35% concentrate or the all roughage ration produced similar gains without any health or disease problems.

Lofgreen *et al.* (1983) evaluated three different types of starting rations. Cattle received on grass hay alone had the poorest average daily gain and efficiency (.21 lb, 45.5:1), whereas, those on a 75% concentrate ration produced the best daily gain and feed conversion (2.35 lb, 4.77:1). Calves receiving the hay plus 2.0 lbs of a 40% protein supplement were intermediate in daily gain and feed efficiency (1.25, 8.91:1).

Hutcheson (1984) compared a hay ration to a milled feed ration containing 35 Mcal NEp fed to calves for three days prior to shipment to the feedlot. He noted a 16 percentage unit difference in morbidity and an 11 percentage unit difference in mortality with cattle receiving the hay ration.

Lofgreen (1978) compared rations containing 25, 50, and 75% concentrate. He noted that calves receiving the 50% concentrate ration consumed more feed, gained the most weight, and showed a lower death loss. The 25% concentrate ration produced the poorest results. Performance of all calves was improved when alfalfa hay was available free-choice.

Because of the poor performance shown with high roughage ration and the potential for rumen malfunction problems with calves on a high concentrate ration, Ralston Purina recommends a ration containing approximately 50% concentrate for cattle weighing more than 350 lbs and a 70% concentrate ration for lighter weight calves.

Potassium

Considerable research has been conducted to evaluate the level of potassium required for the new feedlot arrivals. Their requirement is probably higher because of their greater body fluid loss than that of calves in a preconditioning program. However, the potassium requirement of the preconditioned calf is probably higher than that of the non-stressed calf.

Hutcheson (1984) reported that average daily gain of the new feedlot arrivals was best when rations containing 1.27 and 1.41% potassium were fed. Cole and Hutcheson (1982) reported that increasing the potassium from 0.8% to 1.3% did not effect gain but did reduce death loss from 15 down to 9.0%. Ralston Purina (1979) observed a 3.6% increase in daily gain and a 1.6% improvement in feed efficiency when the potassium level was increased from 0.8% to 1.4%.

Vitamins

Vitamins of the B-complex are normally produced at levels to meet requirements by the microorganisms in the rumen. However, because of the reduced level of rumen microflora in the stressed calf, considerable research has been conducted in this area. Cole et al. (1982) suggested that sometimes B vitamins may be beneficial to the stressed calves but at other times, may be detrimental to performance.

Ralston Purina (1973) conducted a series of trials evaluating addition of whey and a level of B vitamins comparable to those found in whey. Results of these studies showed a reduction in performance of the treated groups. These results were similar to those observed by Davis et al. (1974), where performance of thiamine-supplemented calves was less than that of controls. These results differ slightly from that of Overfield and Hatfield (1976) and Brethour and Duitsman (1972), where they observed a small improvement in daily gain and feed efficiency when niacin and thiamine, respectively, were supplemented.

In general, injections of vitamins A and D have given a slight response in the stressed calf. Cole (1982) summarized the work of Brethour and Duitsman (1974), Davis and Caley (1977, 1981), and Davis et al. (1974, 1975), and stated that injections of Vitamins A and D during processing yielded only modest improvements in animal health and daily gain.

Cook et al. (1982) did not observe any response to an injection of vitamins A, D, and E.

Feed Additives for the Stressed Calf

American Cyanamid summarized 27 trials conducted at 7 locations and found that the addition of AS700 to the ration of the stressed calf resulted in a 54% decrease in number of cattle treated, a 23% increase in average daily gain, and a 19% improvement in feed efficiency. More recent trials conducted by Ralston Purina (1978, 1984) saw improvement of 7.5% in average daily gain and 7.0% in feed efficiency. Similar results were shown by Males (1984). The inclusion of AS700 improved gain and feed efficiency by 11.3 and 9.7% respectively.

Coccidiosis is becoming more of an apparent problem with stressed calves. The improvement in performance resulting from the addition of a coccidiostat will depend on the status of the calves. Results of one trial conducted by Ralston Purina (1984) saw no improvements in performance with the inclusion in the starting ration of a coccidiostat. Similar results were shown in a study by Prouty *et al. (1981); however, Barnes et al.* (1984) showed a significant improvement in daily gain with the addition of a coccidiostat. Clinical coccidiosis was noted in the control cattle, whereas, none was observed in the treated cattle.

Ralston Purina (1977, 1978) has conducted 4 trials evaluating addition of sodium bicarbonate to the ration of stressed cattle. The results of these trials evaluating 0.375-1.5% added sodium bicarbonate were variable and inconsistent. Similar responses were noted by Brethour and Duitsman (1972, 1973, and 1976).

Ration Type Required for the Stressed Calf

The type of ration fed the stressed calf is just as important as the nutrition it contains. If a ration is not palatable or if the density is such that nutrient intake is restricted, performance of the stressed calf is reduced.

Silage is a major component of most rations. Results of trials conducted by Cook *et al.* (1982) and Ralston Purina (1971) has shown an improvement in average daily gain from 51.5-105% when a milled ration was compared to one containing silage. This improvement in performance was primarily due to an increase in dry matter intake.

Ration palatability was apparent in a study by Preston and Smith (1974), where they observed that cattle started on hay had greater daily gains during the first week compared to those started on silage. However, after the first week, this trend was reversed.

The health of cattle has been good on high hay rations; however, the average daily gain and feed efficiency have been quite poor. Hay rations have resulted in a reduction in gain of from 42-53% compared to a milled feed in studies reported by Kercher (1969) and Ralston Purina (1972).

Summary

Animal health is an important aspect of a preconditioning program; however, average daily gain and feed efficiency are extremely important if the program is to be profitable for the cow:calf producer. Not all calves are stressed to the same degree and as a result, not all calves will respond equally to a given treatment or nutritional level. Considering this and the research data available, Ralston Purina recommends the following nutritional specifications as a percent of the ration dry matter:

	Light Calves (<350 lbs.)	Heavy Calves (>350 lbs.)
Protein, %	15.5	13.3
NPN, %	0.22	0.22
Calcium, %	0.66	0.66
Phosphorus, %	0.44	0.44
Vitamin A, IU/lb.	5500	5500
Potassium, %	1.3	1.3
Roughage, %	25.0	45.0

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Abstracts

Therapeutic strategies involving antimicrobial treatment of the central nervous system in large animals

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JAVMA, Vol 185, No. 10, November 15, 1984

Rational therapy of microbial infections within the CNS of any species requires an understanding of the anatomic and physiologic entities known as the blood-brain and the blood CSF barriers. Although outside of the CNS, drugs and other solutes traverse an extracellular route in passing out of the blood (through intercellular clefts between endothelial cells and then through fenestrations in the capillary basement membrane), the situation is entirely different when the CNS is involved. Tight junctions exist between the endothelial cells of capillaries, thus a transcellular route becomes necessary. Drugs must travel across an inner capillary bimolecular lipid membrane, through endothelial cytoplasm, across an outer bimolecular lipid membrane, across a CNS capillary membrane without fenestrations, and finally through numerous glial cell-foot processes.

The blood-CSF barrier consists of apical tight junctions between epithelial cells of the choroid plexus. The importance of the differences between the blood-brain and the blood-CSF barrier is unknown; however, certain differences appear to exist for many antimicrobial agents in their capacity to penetrate the CSF vs the brain tissue. For example, chloramphenicol is concentrated 9-fold in the brain with respect to plasma, whereas CSF chloramphenicol concentration is only 50% of simultaneous plasma concentration. Trimethoprim and sulfamethoxazole, which easily penetrate the blood-CSF barrier, give low brain tissue concentrations.

Calculation of dosage regimens of antimicrobial drugs for the neonatal patient

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JAVMA, Vol 185, No. 10, November 15, 1984

Administration of drugs to the neonatal animal should take into consideration the immaturity of organ systems and mechanisms that affect the drug concentration in target tissues and at receptors. During the first postnatal month, the neonate undergoes considerable change in its ability to absorb, metabolize, and excrete drugs. The rate at which this adaptation from fetal to postnatal life occurs is most rapid during the first 5 to 7 days after birth, but may continue for 6 to 8 weeks or more depending on the process and species.

Factors governing antibiotic doses are the same as those affecting other medications. Dose is governed by the physical characteristics and pharmaceutic formulation of the preparation, by physiochemical properties of the drug substance that governs its fate, and by factors pertaining to the animal itself. To formulate appropriate antibiotic dosage regimens, changes in the newborn which affect its ability to absorb, distribute, and eliminate drugs need to be understood.

A rational approach to the selection of an antimicrobial agent

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JAVMA, Vol 185, No. 10, November 15, 1984

Rational therapy is based on the combination of clinical judgment, overall medical knowledge, and information about the specific patient (and client) obtained from history and clinical and laboratory studies. The rational use of an antimicrobial drug in the treatment of bacterial disease presupposes a knowledge of the nature of the etiologic agent(s) involved in an infectious process. Without knowledge of the etiologic agent involved, the use of an antimicrobial drug is irrational. Such usage puts the patient at unnecessary risk. Irrational therapy also subjects the general human and animal populations to unnecessary risk by encouraging evolution of resistant organisms.

Sequential steps in developing a rational therapeutic plan should include: (1) development of a reasonable suspicion based on the patient's clinical signs and the veterinarian's knowledge of the medicine and microbiologic characteristics of the condition; (2) careful specimen procurement and handling; (3) if possible, the initial detection of organisms by direct smear examination; (4) institution of preliminary antimicrobic therapy based on results of steps 1 and 3; and (5) adjustment, if necessary, of antimicrobial therapy based on interpretation of culture and susceptibility test results.