A STUDY ON THE EFFECT OF A MASSIVE PROPHYLACTIC DOSE OF VITAMINS A AND D ON THE NEONATAL DAIRY CALF[1])

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SUMMARY

Neonatal dairy calves received during the first two weeks of life single prophylactic doses of as much as 1 million I.U. of vitamin A and 500.000 I.U. of vitamin D. Body gains, the calcium, phosphorus and alkaline phosphatase of the blood as well as histological sections of several critical tissues were examined up to two weeks after dosing. Based on these criteria there were no deleterious effects of the treatment.

INTRODUCTION

The Dutch extension service usually advises the farmers to feed supplemental vitamins A and D to their dairy calves born during the winter months. Based on the vitamin D content of Dutch roughages it has been demonstrated recently (21) that without this policy an insufficient supply of vitamin D is not imaginary. Feeding trials with dairy calves in Norway have substantiated this view (15).

To circumvent the practical difficulty of feeding vitamins A and D daily, it has been advised to dose the national dairy calf once only with a rather large amount of vitamins A and D. In general the recommendation has been to feed 500.000 I.U. of vitamin A and 250.000 I.U. of vitamin D in the milk. The purpose of such treatment has been to augment the low reserves of these vitamins normally found in the newborn calf and to insure an adequate supply in cases, where the diet may be inadequate.

In recent years, the dose recommendation has been critized especially in regard to vitamin D. It has been felt, that it is too high and may therefore be harmful. There is no doubt that excessive amounts of either vitamin A or D may be toxic (1, 16) though the problem has not been studied extensively in dairy calves.

Large doses of vitamins, including vitamin D have been given to newborn calves (5, 6, 12, 17) as it had been claimed that supplementary vitamins would prevent early calfhood disturbances. The vitamin D dose, however, never exceeded 50.000 I.U. (5, 6) and ill effects or even a favourable influence on scours, pneumonia etc. were never observed.

HIBBS et al. (11, 13, 14) gave astonishing amounts of vitamin D to dairy cows with a milk fever history. Several dosing schedules, varying from 1 to 5 million units daily during some weeks or 5 to 30 million units daily during several days prepartum have been used. They state that the results of toxicity

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studies in which 30 million units of vitamin D were fed for various periods showed no serious pathologic effects when administration was limited to ten days or less. However, prolonged feeding of the 30 million units for 21 to 30 days resulted in definite signs of toxicity. On this basis it would seem wise to limit the feeding of vitamin D to seven days or less in order to avoid any possible harmful effects in the dairy cows and to provide a margin of safety (13).

Another group of data concerns the vitamin D routinely given to lambs (4, 7) and heifers (8) in the prevention or cure of rickets. Commonly 1 to 2 million units, fed once or twice during the winter season were sufficient. It has been stated (9) that the healthy lamb is well able to tolerate a massive dose of 2 million units of vitamin D, whereas in the sick or unthrifty animal a dose of one million units may have a toxic effect.

SMITH (18, 19) tried successfully to improve calcium retention and to prevent hypocalcemia in milk fed calves by feeding them 70.000 to 140.000 I.U. of vitamin D daily for several weeks. No evidence of any toxicity was reported. CONRAD et al. (2) studied the effect of massive doses of vitamin D on the physiological behaviour of calcium in six month old Hereford calves. A tracer dose of Ca^{45} was administered orally or intravenously and 5 million I.U. of vitamin D were fed orally during five consecutive days. In some calves this latter treatment was continued for an additional 10 days, in which case the total dose amounted to 75 million I.U. of vitamin D. In balance experiments the usual effects of vitamin D administration were observed (3): increased absorption, reduced endogenous losses and a higher retention. Analyses of several soft tissues, including the kidneys did not show any increase in calcium content in those dosed with 25 million I.U. of vitamin D. The kidneys of calves, treated with 75 million I.U. showed a calcium accumulation when the animals were slaughtered two days after the last dose of 25 million I.U. had been given. This symptom, however, was of a temporary nature as the kidneys were of normal calcium concentration in similarly treated calves killed six days later.

Although these data strongly suggest that a dose of 250.000 I.U. of vitamin D, as is recommended in the Netherlands, has to be considered as harmless, it was nevertheless decided to check this point experimentally.

EXPERIMENTAL

In April 1957 a pilot experiment was conducted with three neonatal Friesian Holstein calves of the herd at Wageningen. The experiment lasted sixteen days after the dose of 250.000 I.U. of vitamin D_3 and 500.000 I.U. of vitamin A had been fed in the milk [5]).

During this period each calf received six litres of whole milk daily. Blood was analyzed for calcium, phosphorus and alkaline phosphatase by standard procedures (10) at the start and the end of the experiment. Then all animals were slaughtered and samples of several soft tissues, including kidney, aorta and heart were saved for histological examination [6]). Four times during the

[5]) For these experiments Duphasol A + D_3 was kindly placed at our disposal by N.V. Philips-Roxane, Weesp, Netherlands.

[6]) We are pleased to acknowledge that Dr. G. WIERTZ, Laboratory of Animal Physiology, took care of this part of the experiment.

experimental period the urine was analyzed for protein. This reaction was never positive. The blood findings, pooled in table 1 do not show an undesirable trend as a consequence of the feeding of supplemental vitamin D.

Table 1 Calcium, phosphorus and phosphatase content in blood serum of three calves (pilot experiment).

Days after dosing	0	16
Calcium (mg. per cent)	13.46	11.18
Phosphorus (mg. per cent)	9.11	8.73
Phosphatase (Bodansky units)	11.60	9.74

Histological examination did not show any irregularities except in the intima of the heart of one calf. However, it could not be stated that this was caused by the feeding of vitamines A and D.

During the Spring of 1958 the experiment was repeated on a larger scale at the Department of Animal Husbandry of Cornell University. Thirteen calves of Holstein–Friesian type were either purchased from local auctions or secured from the Cornell University herd at three days of age. They were placed in individual pens, bedded on shavings and fed Holstein milk at the rate of 8 to 9 pounds per day. A commercial 20 per cent total protein calf starter, mixed legume hay and water were offered ad libitum (20). All calves received 15 grams of sulfathalidine on arrival at the experimental barn and in addition each was fed 30 mg. of chloretetracycline as Aurofac D in the milk. As secured, they were randomly assigned to receive either a single dose (250.000 I.U. of vitamin D and 500.000 I.U. of vitamin A) or twice this amount as Duphasol A + D_3 in the milk at one morning feed before they were 14 days of age. A blood sample was drawn just before dosing, 48 hours later and again 14 days after dosing. The coagulated blood was centrifuged and the serum analyzed for calcium, phosphorus and alkaline phosphatase (10). Fourteen days after dosing 11 calves which were available for slaughter were stunned, bled out and samples of the liver, kidney, lung, thyroid gland, dorsal aorta, pulmonary artery, intercostal musele (1st and 2d rib), esophagus and abomasum saved for histological examination. Many of these tissues are sites of metastatic calcification usually seen in cases of vitamin D intoxication. All tissues were fixed in 10 per cent aqueous formalin within one hour of death. After 48 hours fixation, they were processed and imbedded in the usual manner and examined after staining with Delafields hematoxylin and eosin B.

RESULTS AND DISCUSSION (main experiment 1958)

All calves appeared normal during the 14 day experimental period and gained at the rate of about 0.6 lbs per day. The histological examination revealed no evidence of any lesions attributable to an excess of vitamin A or D. Minor lesions such as white spotted kidney, interstitial nephritis and parasite lesions were observed in a few calves. These are not uncommon findings and were not believed to be the result of the treatments imposed. The results of the blood analyses of all thirteen calves have been summarized in table 2.

Table 2 The influence of massive prophylactic doses of vitamins A and D on the serum calcium, phosphorus and phosphatase levels of young dairy calves.

Days after dosing	No. of calves	Calcium mg per cent	Phosphorus mg per cent	Phosphatase Bodansky units [2]	Phosphatase Bodansky units [3]
		Single dose			
Predosing ..	7	11.68 ± 0.17 [1]	7.16 ± 0.45	8.28 ± 1.77	6.57 ± 0.57
2 days ...	7	11.88 ± 0.21	8.28 ± 0.36	6.79 ± 1.25	5.65 ± 0.59
14 days ...	7	11.99 ± 0.24	8.94 ± 0.21	7.97 ± 0.47	7.66 ± 0.42
		Double dose			
Predosing ..	6	11.62 ± 0.33	7.44 ± 0.28	8.95 ± 2.15	5.70 ± 0.92
2 days ...	6	11.59 ± 0.47	7.96 ± 0.61	6.37 ± 1.44	4.17 ± 0.53
14 days ...	6	11.43 ± 0.27	8.47 ± 0.57	6.76 ± 0.78	7.01 ± 1.14

1) Standard error.
2) Including three calves (two in double dose and one in single dose) that had a markedly high level in the predose sample.
3) Excluding the calves mentioned in footnote 2 above.

Comparing the pre-dose values with those taken after treatment reveals relatively little change for any of the constituents. All are within normal levels. The phosphatase values for three calves were abnormally high when first sampled (14–18 Bodansky Units) and declined rapidly to the average by 14 days. For clarity, the average values with and without these calves have been reported separately in table 2.

From the evidence presented in this report it does not appear that either of the levels of the vitamins administered have been deleterious to the calf in any way, which is not surprising with the background of the cited literature.

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