some other area of low commercial value.

It appears that effective control of the acute phase of copper poisoning in sheep can be obtained by the subcutaneous injection of tetrathiomolybdate. This route of administration is as effective as the intravenous route, which has previously been used with considerable success, provided that the dose rate is increased. This new treatment regimen has obvious advantages in terms of cost and convenience and lends itself to use in unskilled hands. It has already been used to control outbreaks of copper poisoning in commercial flocks. Over 400 animals were at risk but none of them developed the haemolytic crisis after treatment was initiated and there were no adverse effects.

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Economic and reproductive consequences of retained placenta in dairy cattle

I. Joosten, J. Stelwagen, A. A. Dijkhuizen

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The financial losses due to retained placenta in Dutch dairy cattle were estimated by using two different methods of calculation. A data-set containing the birth records of 160,188 Meuse-Rhine-Yssel cows provided data on the reproductive performance of cows with and without retained placenta. The fertility of cows after retention of the placenta appeared to be affected. An economic calculation made by adding the losses due to increased calving interval, increased culling rate, loss of milk production and the costs of veterinary treatment and drugs revealed that the total loss due to retained placenta was £471 per year for a 100-cow farm with an average incidence of the condition (6·6 per cent). For a 'problem' farm with a 30 per cent rate, the loss was £2139 per year. A computer farm simulation model, based on a stochastic determination of events, was used to make calculations for circumstances closely resembling those on farms. A 6·6 per cent rate of retained placenta caused a small but significant decrease in net return on labour and management; however, a 30 per cent rate caused highly significant changes. The economic effects of retained placenta were similar in magnitude in herds of high or low productivity and high or low fertility. Sensitivity analysis showed that the greatest financial losses were caused by loss of milk production, followed by the number of animals suffering from complications. The financial losses in herds with an average rate of retained placenta were thus of limited economic importance and therapeutic measures alone should be adequate. However, in a herd with a high rate of retained placenta the financial losses were considerable, and preventive measures for the whole herd could easily be justified.

ECONOMIC losses due to reproductive failure in Dutch dairy cattle have been estimated to be equivalent to 10 per cent of an average farmer's income (Dijkhuizen and others 1985). One of the disorders contributing to this reproductive failure is retained placenta which, especially when followed by metritis, is associated with a decrease in pregnancy rate after first service, an increase in the number of inseminations per conception, an increase in the number of days open, a subsequent longer calving interval, higher culling rates and loss of milk production (Dyrendahl and others 1977, Romaniuk 1978, Bostedt 1979, Sandals and others 1979, Lotthammer 1981, Halpern and others 1985). As a result, many authors associate retained placenta with considerable financial loss. However, the literature concerning the extent of this loss, either at farm level or calculated for an individual cow, is scarce (Lotthammer 1981). This paper provides an assessment of the financial implications of retained placenta at farm level. First, the effect on fertility was determined from the empirical study population. A simple calculation by hand provided a tool for making quick economic calculations. A computer farm simulation model was used to make calculations based on circumstances as close as possible to those on farms and indicated the extent to which retained placenta is a recognisable economic problem within dairy farm management. By analysing several variations, the financial losses due to retained placenta under different circumstances have been clarified; this analysis may help to provide an insight into the economic feasibility of developing and improving preventive and therapeutic measures.

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Materials and methods

The data consisted of 369,288 calving records from 160,188 Dutch Meuse-Rhine-Yssel cows (a dairy breed also suited for beef production). The set was derived from the birth registration data (1975 to 1984) of the artificial insemination centre 'de Kempen', situated in the southern part of the Netherlands. A detailed description of the data-set has been presented (Joosten and others 1987). The calvings were divided into four groups. First, normal or easy calvings without retained placenta (NNRP); these comprised 88·2 per cent of the total; secondly, normal calvings with retained placenta (NRP) which comprised 5·2 per cent, thirdly, abnormal calvings (including difficult calvings, caesarean operations, fetotomy or abortion) without retained placenta (ANRP) which comprised 5·2 per cent and, fourthly, abnormal calvings with retained placenta (ARP) which comprised 1·4 per cent of the total calvings. For each group, the calving rate after first insemination, the number of days to first service, the number of inseminations per conception, the calving interval and the culling rate were calculated. Differences were analysed by a *t* test for differences between means and a χ^2 test for independence.

Methods of economic calculation: creation of the basic set-up

All prices were originally in Dutch guilders and have been converted to sterling using an exchange rate of 3.30.

Calculations by hand.– The total loss due to retained placenta was calculated by adding the losses due to the following contributing causes. The losses due to increased calving interval were estimated to average £0.60 per day, taking into account that the costs of each additional day are not uniform (Dijkhuizen and others 1985). The losses due to increased culling rate were calculated by taking into account two different causes of culling, calving problems and fertility problems, for which the financial loss per cow culled was estimated to be £264 and £142 respectively (Dijkhuizen 1983). Based on the ratio ARP:NRP, it was estimated that there were three times as many cows culled for fertility problems as for calving problems. The loss of milk production amounted on average to 207 kg/cow (Lotthammer 1981). The net price of 1 kg of milk was £0.14, representing the milk price less the feed costs, giving a total loss of approximately £29. The costs of veterinary treatment and drugs were estimated to amount to £15 in an uncomplicated case and £30 in a case complicated by metritis. It was assumed that there were approximately equal numbers of complicated and uncomplicated cases (Sandals and others 1979, Erb and others 1981, Dohoo and Martin 1984a, Curtis and others 1985).

The calculations were made for farms with 6·6 per cent retained placenta, the average incidence rate in the study population (Joosten and others 1987) and for farms with 30 per cent retained placenta, representing 'problem' farms.

Computer farm simulation model.– More realistic calculations of the financial losses due to retained placenta were made by using a stochastic simulation model (Dijkhuizen and others 1986). This model can closely imitate variations in farm management, because several events and the effects of decisions can be stochastically determined. Each simulated herd consisted of a fixed number of up to 100 cows individually generated according to a set of predetermined herd characteristics (Table 1). The calculations were made for a period of 15 years, the first five of which were used to stabilise the conditions and the next 10 to calculate the experimental data. For each alternative, the calculations were repeated 20 times to obtain statistically reliable results. Differences in outcome were analysed by a *t* test for differences between means. For this study the model described by Dijkhuizen and others (1986) was adjusted to fit the study population and to cope with the specific consequences of retained placenta. The calving rate for each group was calculated from the data-set. For each cow with retained placenta a loss of milk production averaging 207 kg (Lotthammer 1981) was introduced. This loss was assumed to occur in the first 60 days after calving, divided into three periods of 20 days each. Some of the cows which calve normally and have retained placenta (NRP) tend to develop metritis (Sandals and others 1979, Erb and others 1981, Dohoo and Martin 1984a, Curtis and others 1985). To allow for the effects of this metritis 36·5 per cent (the transfer factor, TF) of these calvings were transferred to the group of cows which did not calve normally and had retained placenta (ARP), and a lower calving rate and a higher production loss were assigned to these calvings. Consequently, the calving rate (CR) of the NRP group after transfer (CR(NRP)t) could be expressed by the equation:

$$CR(NRP)t = (CR(NRP) - TF \times CR(ARP))/(1 - TF)$$

The calving rate of the ARP group was considered to be constant and the same as that of the animals transferred.

The model was used to analyse the results of assuming that herds had either no retained placenta, or 6·6 per cent retained placenta (the average incidence rate in the population), or 30 per cent retained placenta, as an example of a severely affected herd. The model was then used to assess the effects of variations in the oestrus detection rate, the calving rate after first insemination and the loss of milk production for the four groups of cows, as tabulated below

	Retained placenta 0%	Retained placenta 6·6%	Retained placenta 30%
Oestrus detection rate (%)	70	70	70
NNRP (%)	94·8	88·2	64·8
ANRP (%)	5·2	5·2	5·2
NRP (%)	0	5·2	23·6
ARP (%)	0	1·4	6·4
Calving rate after first insemination			
NNRP (%)	61·0	61·0	61·0
ANRP (rate relative to NOR)	91·4	91·4	91·4
NRP (rate relative to NOR)	87·4	87·4	87·4
ARP (rate relative to NOR)	82·4	82·4	82·4
Transfer factor (%)	–	36·5	36·5
Milk production loss (%) for			
NRP Period 1	–	17	17
Period 2	–	7	7
Period 3	–	2	2
ARP Period 1	–	34	34
Period 2	–	14	14
Period 3	–	8·5	8·5
Total milk yield (kg/305 days)	6275	6275	6275

Variations analysed within the 6·6 per cent and 30 per cent retained placenta groups allowed for production losses in NRP and ARP groups of half or twice those specified, transfer factors of 10 and 63 per cent and calving rates 10 per cent or higher lower than those specified.

Variations analysed for all the cows included 305-day milk yields of 7275 kg and 5275 kg, and high and low fertility levels for the 0 per cent, 6·6 per cent and 30 per cent retained placenta groups, with an oestrus detection rate of 90 per cent and a calving rate for NNRP cows of 81 per cent, and an oestrus detection rate of 50 per cent and a calving rate for NNRP cows of 41 per cent.

Results

The fertility of the cows was affected by retained placenta. A comparison of cows with and without retained placenta (Table 2) shows increases in the number of days to first insemination and number of inseminations per conception, and increases in the calving interval and culling rate ($P < 0·01$). The calving rate after first insemination was decreased ($P < 0·01$). When the calving process was also considered, the fig-

TABLE 1: Major characteristics of the initial herd(s)

Reproduction traits	
Oestrus detection rate (%)	70
Average calving rate (%)	61·0
% of calving problems and puerperial disturbances (retained placenta excluded)	5·2
% of retained placenta	0
Average calving rate problem cows (%)	55·8
Breeding and culling policy	
Cows with a relative production level of ≤ 80%	No breeding
Cows with a relative production level of 81 – 90% max. allowable calving interval (days)	440
Cows with a relative production level of > 90% max. allowable calving interval (days)	520
Prices and costs	
Milk price (£ per kg)	
Fat	3·25
Protein	3·25
Milk volume	– 0·02
Price roughage (£ per 1000 Dutch feed units)	0·11
Price concentrates (ditto)	0·17
Veterinary services and drugs	27

TABLE 2: Fertility parameters (mean ± sd) calculated for four groups of calvings separately and combined (two by two based on the absence or presence of retained placenta). Total number of calvings 369,288

	NNRP	ANRP	NRP	ARP	NNRP+ANRP	NRP+ARP
Days to first insemination	84·5[b] ±35·1	86·8 ±43·6	88·0 ±32·6	87·4 ±60·5	84·6[a] ±35·6	87·9 ±39·1
Calving rate after first insemination (%)	61·0[c]	55·8	53·3	50·3	60·7	53·0
Average calving interval (days)	384·6[b] ±50·0	392·3 ±57·9	395·2 ±52·7	395·5 ±76·9	385·0 ±50·9	395·3 ±57·5
Number of inseminations per conception	1·75[b] ±1·18	1·96 ±1·37	1·94 ±1·30	2.01 ±1·34	1.76 ±1·19	1·95 ±1·31
Culling rate (%)	22·9[d]	27·6	29·4	36·7	23·1	31·0

NNRP/ANRP Normal/abnormal calvings, no retained placenta
NRP/ARP Normal/abnormal calvings, with retained placenta
[a] For each parameter figures differ significantly between the groups with and without retained placenta (NRP+ARP v NNRP+ANRP) $P < 0·001$
[b] Figures for the NNRP group differ significantly from those of the other groups ($P < 0·01$). Differences between the other groups are not significant at the 0·01 level.
[c] Figures for all groups differ significantly ($P < 0·01$) except between the NRP and ARP group
[d] Figures for all groups differ significantly ($P < 0·01$) except between the ANRP and NRP group

ures for the NRP and ARP groups did not differ, except in the case of culling rate. Even so, the figures for the ANRP group were not significantly different from the NRP and ARP groups, with the exception of calving rate.

The financial losses per cow due to retained placenta, calculated by hand, were as follows.

There was an average increase in calving interval of 10·3 days with a financial loss of 10·3 × £0.60 = £6.20.

There was an average increase in culling rate of 7·9 per cent, 25 per cent due to calving problems at £264 per cow and 75 per cent due to fertility problems at £142 per cow, giving an average cost per cow culled of £172.5. The financial loss was therefore 0.079 × £172.5 = £13.63.

The average loss of milk production was 207 kg, with a financial loss of 207 × £0.14 = £28.98.

The cost of veterinary treatment and drugs for simple cases was £15 per cow, and for cases complicated by metritis £30 per cow. There were approximately equal numbers of simple and complicated cases, giving an average financial loss of £22.50.

The total financial loss was therefore £71.31.

For a farm with a herd of 100 cows and a rate of retained placenta of 6·6 per cent or 30 per cent, the annual financial loss would be as follows:

Loss (£) due to:	Incidence of retained placenta (%) 6·6	30
Calving interval	41	186 (9%)
Culling rate	90	409 (19%)
Milk production	191	869 (40%)
Veterinary service	149	675 (32%)
Total	471	2139 (100%)

Using the farm simulation model, for a herd with no retained placenta the net return on labour and management would have been £368 per cow per year (Table 3). A 6·6 per cent rate of retained placenta did not significantly change the herd's productivity or fertility, but there was a tendency towards a small but significant decrease in net return (£6 $P < 0·05$). A 30 per cent rate, however, caused highly significant changes. Milk production decreased and the calving interval and culling rate increased ($P < 0·005$) owing to reproductive failure, resulting in an average loss in net return of £22 per cow ($P < 0·005$).

TABLE 3: The changes in net return on labour and management as a result of changes in mean production and reproduction parameters due to different rates of retained placenta. The figures in the 6·6 per cent and 30 per cent columns are compared with the figures for 0 per cent retained placenta

	Incidence of retained placenta (%) 0	basic set-up 6·6	30
Mean milk yield per cow (kg)	5951	−25	−91***
Calving interval (days)			
herd average	377	+1*	+6***
cows ≥ 410 days (%)	16	+1	+5**
Fertility status †	65	−1	−7***
Annual culling rate due to			
Reproductive failure	2·8	+0·2	+0·6***
Production failure	3·2	+0·3	+0·2
Total	20·8	+0·6	+0·5
Cows not pregnant (%)	3·4	+0·2	+0·6***
Cows not inseminated (%)	3·5	+0·2	+0·2
Net return on labour and management (£/cow/year)	368	−6*	−22***

* $P < 0·05$, ** $P < 0·01$, *** $P < 0·005$
† Fertility status is pregnancy rate after first breeding/number of inseminations per conception − (interval from calving to conception − 125)

TABLE 4: The effect of retained placenta on herds with high and low production levels. The figures in the 6·6 per cent and 30 per cent columns are compared with the corresponding levels in the column for 0 per cent retained placenta

	Incidence of retained placenta (%) 0 High production	0 Low production	6·6 High production	6·6 Low production	30 High production	30 Low production
Mean milk yield per cow (kg)	6695	5071	−1	−19	−113***	−80***
Calving interval (days)						
herd average	377	377	+1***	+1	+6***	+6***
Cows ≥ 410 days (%)	16	16	+1	+1	+5**	+4**
Fertility status †	66	65	−2**	0	−8***	−6***
Annual culling rate due to						
reproductive failure	2·7	2·8	+0·1	+0.2	+0·8***	+0.9***
Production failure	2·7	3·7	+0·2	0	+0·1	−0·1
Total	20·5	21·0	+0·2	+0·5	+0·7	+0·7
Cows not pregnant (%)	3·3	3·4	+0·1	+0·3	+0·8***	+0·9***
Cows not inseminated (%)	2·9	3·9	+0·2	0	+0·2	0·1
Net return on labour and management (£/cow/year)	479	235	−3	−4	−22***	−19***

* $P < 0·05$, ** $P < 0·01$, *** $P < 0·005$
† Fertility status is pregnancy rate after first breeding/number of inseminations per conception − (interval from calving to conception in days − 125)

TABLE 5: The effect of retained placenta on herds with high and low fertility levels. The figures in the 6·6 per cent and 30 per cent columns are compared with the corresponding levels in the column for 0 per cent retained placenta

	Incidence of retained placenta (%) 0 High fertility	0 Low fertility	6·6 High fertility	6·6 Low fertility	30 High fertility	30 Low fertility
Mean milk yield per cow (kg)	5994	5796	−21	−24	−74***	−88***
Calving interval (days)						
Herd average	360	399	+1***	0	+6***	+4***
Cows ≥ 410 days (%)	4	34	0	+1	+3**	+4**
Fertility status †	100	33	−1	0	−9***	−4***
Annual culling rate due to						
Reproductive failure	0·3	16·3	0	+1·0*	+0·1*	+2·4***
Production failure	3·0	4·1	+0·2	−0·1	−0·2	0
Total	19·5	33·0	0	+0·8	−0·3	+2·2
Cows not pregnant (%)	1·1	17·0	+0·1	+0·8	+0·1	+2·4***
Cows not inseminated (%)	3·3	4·3	0	0	−0·3	+0·1
Net return on labour and management (£/cow/year)	372	338	−3	−4	−19***	−22***

* P < 0·05, ** P < 0·01, *** P < 0·005
† Fertility status is pregnancy rate after first breeding/number of inseminations per conception − (interval from calving to conception in days − 125)

Tables 4 and 5 reveal that there was little difference in the influence of retained placenta on herds with either high or low milk production or high or low fertility levels. The relatively large decrease in milk yield at a high production level with a [illegible] per cent rate of retained placenta (Table 4) was accounted for by the fact that the loss ascribed to cows with retained placenta was calculated proportionally. Herds with a low fertility level (Table 5) appeared to be more susceptible to changes in reproductive performance, especially with regard to culling rate and the percentage of cows not pregnant. This resulted in a slightly larger effect on the net return.

Sensitivity analysis of the characteristics ascribed to cows with retained placenta showed that at the 6·6 per cent level the effects were so slight that they could not be separated from the stochastically determined variance. At the 30 per cent level (Table 6) fluctuations in production loss had a large effect on the net return, a doubled loss causing an extra £11 decrease in net return ($P < 0{\cdot}005$). The effect of the number of animals suffering from complications (expressed in the transfer factor) was far less; although their effect was not significant when compared with a transfer factor of 36·5, the difference in net return between a transfer factor of 10 and one of 63 was significant at the 0·05 level. Changes in calving rate had no significant effect on the net return.

Discussion

Retained placenta is a reproductive disorder which occurs at the end of one reproductive cycle and has repercussions on the next. The present study shows that fertility after retained placenta is impaired, as has also been reported by Dyrendahl and others (1977), Romaniuk (1978), Bostedt (1979), Lotthammer (1981) and Halpern and others (1985). There are some contradictory reports (Muller and Owens 1974, Kay 1978) but it should be kept in mind that retained placenta leads to metritis and cystic ovaries in more than 50 per cent of cases. These problems add to, or are the predominant cause of the decrease in fertility (Sandals and others 1979, Erb and others 1981, Dohoo and Martin 1984b, Curtis and others 1985). Calving and fertility problems are the main cause of the higher culling rate. Milk production losses have been reported by Lotthammer (1981), Dohoo and Martin (1984b) and Rowlands and Lucey (1986); Kay (1978) reported a decrease which was not significant. In this study it was not known whether the animals with retained placenta also suffered from other diseases. The percentage of complications was derived from the literature and the calculations were made accordingly. It was not possible to control for any other disease that might have influenced the fertility. However, because of the large numbers analysed, a random distribution of the effect over the groups with and without retained placenta may reasonably be assumed.

The financial losses due to retained placenta were computed by adding the losses due to decreased fertility, higher culling rate, reduced milk production and the costs of veterinary services. Hand calculations revealed that 40 per cent of the total loss was due to decreased milk production. Veterinary treatment accounted for 32 per cent, culling for 19 per cent and increased calving interval for 9 per cent. However, a herd with an average rate of retained placenta of 6·6 per cent would not suffer a substantial loss. For herds in which retained placenta occurred in 30 per cent of cows the loss was considerable. More realistic calculations by means of the farm simulation model demonstrated the same tendency. The loss at a 30 per cent level of retained placenta was substantial (£22 per

TABLE 6: The effect of changes in production and reproductive parameters in cows with retained placenta on the net return on labour and management in a herd with a retained placenta rate of 30 per cent. The figures are compared with the figures in the basic column

	Basic	PL ×0·5	PL ×2	TF 10	TF 63	CR ×1·1	CR ×0·9
Mean milk yield per cow (kg)	5860	+7	−70***	−3	−24	−27	−19
Calving interval (days)							
Herd average	383	0	0	0	0	−1	0
cows ≥ 410 days (%)	21	0	0	0	0	−1	0
Fertility status †	58	0	+1	0	0	+3	−2**
Annual culling rate due to							
reproductive failure	3·4	+0·3	+0·3	0	+0·5	−0·3***	+0·8***
Production failure	3·4	+0·4*	0	+0·1	−0·2	0	+0·1
Total	21·3	+0·9	+0·5	−0·1	+0·2	+0·3	+1·4
Cows not pregnant (%)	4·1	+0·3	+0·3	0	+0·4	−0·4**	+0·6**
Cows not inseminated (%)	3·7	+0·3*	0	+0·1	−0·2	0	
Net return on labour and management (£/cow/year)	346	+2	−11***	+1	−4	−4	−3

PL production loss, TF transfer factor, CR calving rate.
* P < 0·05, ** P < 0·01, *** P < 0·005
† Fertility status is pregnancy rate after first breeding/number of inseminations per conception − (interval from calving to conception in days − 125)

cow per year). At the 6·6 per cent level the loss amounted to £6 per cow per year which, although of limited economic importance, makes the disease recognisable within the framework of other reproductive diseases. The figure is consistent with the figures calculated by Lotthammer (1981) for a population with 6·5 per cent retained placenta, in which the loss per cow per year was DM21 (without culling) and DM27 (with culling). Dijkhuizen and others (1985) estimated that the total loss due to reproductive failure averaged Dfl80 per cow per year. On the same basis, ie, without adding the extra milk production loss, the loss due to retained placenta would be approximately Dfl10 (£3) per cow per year. Retained placenta, therefore, contributes to this loss to an extent of about 12·5 per cent.

The economic effect of retained placenta was not very different in herds with either high or low levels of fertility or milk production. The rate of retained placenta appeared to be the decisive factor in determining the loss.

The influence of the change in characteristics ascribed to cows with retained placenta was most clearly marked at the 30 per cent level. The effects at the 6·6 per cent level were so slight that they tended to be obscured by the stochastic nature of the model, indicating that at this level many other events might obscure the effect of retained placenta. The influence of loss of milk production is clear. Relatively little was known about the exact loss (Lotthammer 1981, Dohoo and Martin 1984b) but recently Rowlands and Lucey (1986) reported a significant reduction of 6 to 7 per cent in peak milk yield and a subsequent 7 per cent reduction in 305-day milk yield. Changes in the calving rate of cows with retained placenta seemed to exert little influence on the net return. The changes in reproductive parameters were as expected, but the changes in milk yield per cow were more surprising. The culling rate may play a role here, because higher culling rates on the one hand decrease milk production (because of a decline in the mean age of the herd) but on the other hand increase milk production (because of a decrease in the total number of days dry). The net result will be stochastically determined. In this respect, the effect of variations in the transfer factor (which determines the percentage of animals suffering from complications after retained placenta) was probably due mainly to decreased milk production and the costs of veterinary treatment.

No preventive measures are available for retained placenta and therapeutic measures are for the most part restricted to antibiotic treatment. As far as the feasibility of developing new methods for prevention and therapy are concerned, the following economic considerations apply. In a herd with the average rate of retained placenta of about 6 to 7 per cent the focus should be on therapeutic measures, to prevent losses of milk production and infertility. Unless they were cheap, preventive measures for the herd as a whole would hardly be justified. However, in a herd with a high rate of retained placenta the financial loss is likely to be so large that, in addition to therapeutic measures, preventive measures should be recommended. Since the rates of retained placenta in a herd are liable to fluctuate widely from one year to another, it may be worthwhile considering some preventive measures, even for herds with relatively low rates.

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Equine Abstracts

Iron toxicity in neonatal foals

NEWBORN Shetland foals died of acute hepatic failure after they had been given 360 mg iron as ferrous fumarate orally. The lesions were indistinguishable from those in foals given an oral digestive inoculant containing the same amount of iron, and were also similar to the 'toxic hepatopathy' syndrome described in foals in the USA in 1983. The dose rates of iron ranged from 14·4 to 29 mg/kg bodyweight, and the effects were more acute in the foals receiving the higher doses although these doses were much lower than the toxic doses reported in other species. The factors which contribute to the foals' sensitivity to iron probably include the following: foals at birth have a high plasma iron concentration and a high proportion of their plasma transferrin is saturated; furthermore, iron absorption is generally higher in neonates than in adults. As a result free iron may reach the tissues and catalyse oxidative damage.

MULLANEY, T. P. & BROWN, C. M. (1988) *Equine Veterinary Journal* 20, 119

Fractures in thoroughbred race horses

THREE major lesions were analysed as the pathological basis of fractures incurred by 53 thoroughbred horses during flat races at a New York track. The condition of the track had no effect on the incidence of the fractures and they could not, therefore, be considered to be traumatic. The three lesions were osteochondrosis, chondro-osteonecrosis and degenerative lesions of tendons and ligaments. Osteochondrosis was expressed as retained cartilage, subchondral cysts, transverse trabeculation of epiphyseal and metaphyseal bone, osteochondrosis dissecans and 'chip fractures'. Chondro-osteo-necrosis was characterised by regressive changes in the articular cartilage and subjacent bone; tendons and ligaments showed degeneration of fibres either with or without dystrophic calcinosis, fatty degeneration of fibres, fibrosis, and chondroid and osseous metaplasia. The paper is illustrated with 112 photographs, photomicrographs and radiographs.

KROOK, L. & MAYLIN, G. A. (1988) *Cornell Veterinarian* 78, (Suppl 11)

Epidermal cell renewal in the horse

SCALE formation often accompanies skin disease in horses and may be due to alterations in the rate of epidermal cell renewal. The normal rate of epidermal cell renewal was determined in eight adult horses by measuring autoradiographically the mean proportion of the basal epidermal cells that had become labelled 40 minutes after an intradermal dose of [^{3}H]thymidine. The mean (± sd) labelling index was 1·45 ± 0·47 per cent, and the cell renewal time derived from this measurement varied from 13 to 25·5 days with a mean value of 17·2 days. This value is similar to that of other mammals, ie, between 13 and 18 days in man and approximately 15 and 22 days in the pig and dog, respectively.

BAKER, B. B., STANNARD, A. A. & MAIBACH, H. I. (1988) *American Journal of Veterinary Research* 49, 520