Preventive Medicine and Mastitis*

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One of the guidelines for preventive veterinary medicine is the economic appraisal of all the preventive measures we use and I propose to use this talk on mastitis to illustrate that guideline.

Mastitis control provides an excellent example of our philosophy on preventive medicine—that we should choose carefully from the available control measures those which in combination yield the highest net profit. In other words, the disease should be limited in its prevalence to the point where the introduction of further control measures would cost more money than was saved.

Mastitis is a disease for which a wide range of control measures have been recommended over the years, and a farmer who adopted them all could just about keep himself fully occupied without doing anything else on the farm! We have been looking at the economic merit of various control measures with a view to deciding which ones we should add to or delete from our recommendations.

It is clear that some measures are not worthwhile, given the present state of knowledge on mastitis control. For example, programs for the eradication of *Strep. agalactiae*, which were very valuable in earlier years, have been rendered economically outdated by more recent developments, and can no longer justify their existence.

Similarly, the development of vaccines for specific organisms (especially *Staph. aureus*), which have long been considered the great hope of mastitis control, can be virtually written off as an economic proposition, even if an effective vaccine is developed, because it can be shown that a vaccine is unlikely to be profitable if added to existing control measures, and could not replace any of our recommended measures.

Although you no doubt recommend a number of the same measures which we support, I will just summarize briefly our experiences with individual aspects of the control program, which is very similar to the programes promoted at the National Institute for Research in Dairying in England, Cornell University and the University of Guelph.

Point 1. Teat dipping of all cows after each milking of lactation.

Although this idea dates back to Moak's original work with pine oil in this country in 1916, it is only in the last ten or fifteen years that the great value of teat dipping has been proven, and even more recently it has come into widespread useage around the world.

In Australia, we had more than our share of problems with teat dips being irritating to teat skin, but this has largely been overcome by formulation of special antiseptic compounds which are highly effective but much less irritating, and we find that the addition of glycerol or paraffin oil to the mixture solves the problem of the few remaining herds which have difficulties with sore teats. We use an iodophor at 0.5% available iodine in most herds, and 4% sodium hypochlorite in one herd. Some of our other herds tried the hypochlorite at our suggestion, but gave it up because it was so irritating to the milker's hands, although it didn't seem to worry the cows so much.

We agree with the criticism of teat dipping that "there must be an easier way," but the evidence suggests that sprays are not satisfactory, and I think we have no alternative except dipping. Our experience has been that its introduction has little effect on milking time, provided the farmer already knows how to organize his milking routine.

Point 2. Dry Period Treatment.

Dry period treatment is the other foundation on which our control program is built. Because it has to be carried out only once a year for each cow, we find it much easier to keep farmers reliably carrying out dry period treatment than it is to keep them dipping teats every day of the year. However, elimination of teat dipping reduces the net return from the control program by almost half, and after a few of our farmers gave up teat dipping and found that infection levels rose substantially, we have persuaded them all to dip teats routinely.

As far as drugs for dry period treatment are concerned, we have used cloxacillin in a slow release base and have obtained very similar cure

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rates to those elsewhere—about 70% of staphylococcal infections and almost 100% of streptococcal infections are eliminated. We had very poor results from products which were not formulated in the slow release base.

The important question is whether all quarters should be treated at drying off, or only those which are diagnosed by some technique as being infected. Treating all quarters ensures that no infected quarters are missed and minimizes the new infection rate during the early part of the dry period, which is, as you know, higher than at any time during lactation.

However, teat dipping after the last milking of lactation prevents most new infections, and farmers are often reluctant to treat all quarters at drying off, because of the cost.

In addition, the work reported by Schalm and his co-workers from Davis suggests that caution should be exercised in regularly treating all quarters at drying off, in case the cows are rendered more susceptible to unusual infections—although the evidence on this point is far from conclusive and may well prove to be of little significance in the field situation.

We also have a general inclination to discourage the unnecessary or excessive use of antibiotics by farmers.

We have chosen to take milk samples before cows are dried off and treat only those we diagnose as positive. I will return to the details of this a little later. I might mention in passing that we place little emphasis on the treatment of clinical mastitis in milking cows.

Our experience is that not only are most of the products used in milking cows of limited value, but the farmer commonly fails to carry out the required number of treatments. We do not, therefore, interfere much with treatment of milking cows but concentrate on dry period treatment.

Routine treatment by the farmer is useful in controlling streptococcal infection, but has little effect on staphylococcal mastitis. In any case, the most rapid benefit of a mastitis control program is that clinical mastitis becomes relatively uncommon, so its treatment becomes of minor importance.

Point 3. Maintenance of the Milking Machine.

Research findings on the role of the milking machine in mastitis control have been contradictory and inconclusive for many years, and it is encouraging to see some answers emerging which, for once, prove that everyone was probably correct! The work in England which has sorted out the situation showed that the milking machine can influence the spread of infection during milking, and this appears to be at least its major role. However, it represents a significant problem only when the vacuum level in the machine is undergoing fluctuation which simultaneously has a cyclic and irregular component. If these two characteristics are present, their effect is more marked during overmilking than during milk flow. This explains why most of the machine factors which research workers have found to be important seem to only operate on some occasions—presumably in a machine which showed the necessary performance characteristics.

The English workers are now experimenting with simple methods of preventing the problem, but in the meantime it is consoling to know that the traditional advice of ensuring that the milking machine is in good working order, avoiding unnecessary entry of air to vacuum pipes, and avoiding overmilking are the best pieces of advice that can be given.

Point 4. Backflushing of Teat Cups.

We regard this as an optional extra which farmers can carry out if they wish. Its cost is low, but there is no clear evidence on whether or not it is effective.

We consider chemical disinfection of teat cups to be ineffective and heat sterilization to be impractical, but backflushing is simple, cheap, and practical. We would, however, like more evidence that it is effective.

The technique involves a metal tee-piece which is inserted into the milk line. While vacuum is present the ball valve makes it impossible for water to enter the milk line—if the farmer is forgetful and tries to backflush while vacuum is present the water squirts out through the valve and usually fills his boots with water, just to remind him! When water is run through the backflushing device correctly, it rinses the teat cups and removes at least part of the contamination on them. It is, of course, essential to use water without serious bacterial contamination.

There are many other control measures which can be used for mastitis, although most of them lack adequate supporting evidence. We consider that, on economic grounds, the four points I have mentioned provide an adequate defense against the disease.

Point 5. Culling Infected Cows.

One of the preventive measures which we have to omit from the program is segregation of the chronically infected cows. We just leave them in

the herd, raise hygiene barriers and treat them at drying off. If they have several attacks of clinical mastitis, they are reviewed relative to culling.

If we are going to divide a herd into groups, it seems to us to be more important to use the segregation to help the fertility program. Certainly it suits the farmers to separate the herd into one group which contains the cows checked to be pregnant and the other group those not yet bred and those bred but not known to be pregnant. He can then concentrate his oestrus detection efforts on this latter group. If he is batch feeding, this is the group which is lactating most heavily and is also requiring care in feeding for maximum fertility. Any further subdivision in the herd is unlikely to be practicable or acceptable to the farmer. It is difficult enough to get farmers to maintain two groups of milking cows to keep up to date with passing cows from one to the other.

Again we have found it difficult to maintain a desirable level of culling for mastitis. Culling for poor fertility, poor production and old age are priority, and our rate of reducing the Q.I.R. is slowed by the number of chronic cases maintained in the herds.

Participation by the Veterinarian in Mastitis Control

It is clear from the points I have discussed that it is not essential to involve a veterinarian directly in the work. We considered that the farmer needed some regular support and guidance, so we took the control measures and built a herd health program around them.

The objective then became to monitor the Quarter Infection Rate so that we knew what we were doing. Even this did not require the physical intervention of a veterinarian. So, I have to declare our second objective. The naked truth then!

It is to get a veterinarian on to every dairy farm periodically, at least four times a year and preferably once a month, to check on the mastitis situation and other matters.

There may be countries where this would not be financially advantageous because of the backwardness of the dairying industry, but in most the fault would often be in the other direction—the veterinarian would have little profit-oriented advice to give. So I take it as one of my functions to keep a lookout for additional tasks for veterinarians on the farm. In some cases the tasks are additional to what we already do. In others they are a replacement for traditionally veterinary tasks which are disappearing as farmers do more of their own salvage work. Just so that I avoid any suggestion of professional nepotism, I hasten to add that I am not promoting a racket!—only trying to ensure that veterinarians are used where and when they can help the community. And they certainly are needed where agricultural animals are.

I am not really concerned about whether they are in private practice or nationalized. The posture, if it is going to succeed, must be the proferring of optional advice, not authoritarian dictation.

So in mastitis control we opted for a monitoring system with veterinary participation. We were already visiting our herds at monthly intervals to examine and treat cows for infertility. We simply added another group of cows to be examined. This was the group scheduled to be dried off during the ensuing month. These cows were examined by the California Mastitis Test and culture of positive reactors to that test.

This provided us with some very important advantages. Firstly, we could continually check on how effective the control program was. It isn't that the program wears thin, it is a fact of life that farmers relax their guards if they are not constantly prompted. This is not a characteristic peculiar to farmers, and the farmer, like everyone else, is susceptible to a steeply rising graph with the curve headed straight for the red zone marked "danger."

Secondly, we got a bacteriological diagnosis and kept on getting one every month. The possibility of *Pseudomonas aeruginosa* getting into the wash water and sneaking past our hygiene barrier is therefore covered. The English workers admit that about one herd in eleven which institutes the veterinary-free and lab-less program still does not get out of difficulties and requires further investigation to find out why.

It might only be 9% of problem farms, but if I contract to do something for a farmer, I think it would be professionally negligent not to do the best possible job, provided, of course, that it returned a financial gain.

The problem was to get veterinary participation without doing frequent, full-herd infection surveys. In these days of large herds milking 300 to 500 cows in batches of twelve at a time in a fast herringbone shed designed to reduce labor costs, the logistics of full herd surveys defeat us. We can do one if we have three skilled workers in the pit, two successive afternoons of three hours each, and delay the milking by only a few minutes. They must be done at milking time.

In these days of vocal hired help, my field technicians and laboratory workers express their dislike. I can hardly blame them when they have to

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deal with 2000 bottles of milk at one time! In addition, the costs of such surveys are high (about $1 per cow) and the returns very doubtful. The answer to us seemed to be to combine the two needs. One was to get a bacteriological examination of a *sample* of cows every month. The other was to detect the bacteriologically positive quarters of the cows to be dried off so that they could be the ones to be treated.

This was rational and practicable in that it reduced the number of cows to about 10% of the herd at each visit, an easy number for the laboratory to handle and small enough to warrant the veterinarian getting down and examining the udders. We did enough full herd surveys to satisfy ourselves that we could get comparable figures from the drying-off Quarter Infection Rate and then thankfully deleted the surveys.

The Quarter Infection Rate in herds using a teat dip/dry period treatment control program is always higher at drying off than at average mid-lactation, the difference being of the order of 1.3 to 1. Thus, our Quarter Infection Rates will be higher than those usually quoted. It is a minor disadvantage that we don't detect an infection until late in lactation, but we don't treat them until the dry period anyway. Although we believe that sampling of cows before drying off is a useful monitoring aid, we find it difficult to decide whether it is best to use it as a basis for limiting dry period treatment.

There are arguments for and against treatment of all quarters, and I have already discussed the work from Davis which makes us have reservations about treatment of all quarters. We have carried out an economic analysis on the relative merits of various treatment systems, and it seems that what you lose on the swings you gain on the roundabouts—the eventual economic benefit of sampling and treating is about the same as treating all quarters.

But sampling and treating get us physically involved in mastitis control, so we have opted for sampling, which enables us to monitor the infection level, and we consider that the results have been highly satisfactory. Some of our farmers have taken up a suggestion of treating the other quarters with a much cheaper but less effective product. It will be interesting to compare their results with those of farmers who do not do this.

We are now using counting of cells in bulk milk with a Coulter Counter as a second method of monitoring the mastitis level in our herds. So far it has proved to agree quite well with our sampling figures, but we are aware of its serious limitations with regard to predicting the mastitis level in an individual herd. At present we are certainly not prepared to give up the sampling and trust the cell count on its own.

Results in Our Herds

I want to turn now to the results of the mastitis control program in our herds.

Some of the herds had already been on the same control program for two years as part of our earlier work and their initial infection levels were lower

Table 1

Preventive Medicine and Mastitis
Quarter Infection Rate at Drying Off Examination
(Q.I.R. at D.O.X.)

Herd No.	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Ro-1	21	17	13	34+		
My-2	22	10	9	8	6	
Pu-4	15*	7	12	25	24	8
B1/2-5/9	42	28	18	27	16	11
Ba-6	15*	16	18	25	12	11
St-7	24	17	13	33+		
Sm-8	12*	12	34	13	12	

*Had been on mastitis control program earlier. + WITH–
+Withdrew from program. N.B. A major deletion of teat dipping plus a laboratory error in the 4th year.

The general pattern has been for infection levels to fall to a figure which has stabilized between 6 and 12% of quarters infected.

As you can see, there has been some fluctuation, and 1971 was a particularly bad year, when the level shot up almost to its starting point before declining again to a very satisfactory figure. The 1971 peak was due to two factors—firstly, we had a period of wholesale defection from teat dipping, which was only reversed when the farmers saw the infection levels going up in our monthly reports; and secondly, the results for that year are an overestimate due to an over-zealous technician who was producing too many positive results—unfortunately this was not detected for some time because it was mixed in with the genuine rise in infection levels.

All our farmers are now teat dipping again, and after the usual delay, infection levels are now quite satisfactory.

I now want to demonstrate the economic benefits of our control program, in comparison with some of the alternative possibilities.

Table 2 shows that our recommendations will cost the farmer a maximum of $213 per 100 cows per year for materials and $233 for our services to his mastitis control program. If he added the other control measures listed, he could run up a total bill of $655, and we consider that he would get only

Table 2

Costs and Benefits of Mastitis Control
(All values quoted for 100 cows per year)

	Costs	
	Our Program	Additional Procedures Recommended by Others
A. Farmer Costs		
Teat Dipping	$105	$105
Treatment ONLY INFECTED	$108	
Dry quarters (at 90¢ per quarter)	(Reducing to $32)	
Treatment all quarters at 90¢ per quarter		$360
Udder Wash with disinfectant		$36-50
Teat Cup Disinfection		$ 73
Rubber Gloves		$ 7
Vaccination		$90 reducing to $60
Labor by farmer	Nil	Nil
Subtotal:	$213	$655
B. Veterinary Costs		
Sampling, labor & mileage	$140	
Laboratory costs (10¢ head RMT, 50¢/head culture all cows)	60	
Data handling Mastitis only	33	
Subtotal:	$233	
Total Cost:	$446	

N.B. Costs our program $341 v $360 for treating all quarters.

slight improvement in performance for his money.

With our monitoring system, total drug and veterinary costs are $341, compared with $360 for treatment of all quarters and no monitoring system. The benefits are shown in Table 3. We have done quite a lot of work on the economics of mastitis control, and there is not time to discuss in detail the calculations that produced these estimates of the benefit from it.

Table 3

Costs and Benefits of Mastitis Control
(All values quoted for 100 cows per year)

Benefits

In herds of average Friesian (Holstein) cattle, yielding annually 374 lbs. butter fat (i.e. 11,000 milk) on pasture. Reduction in Mastitis Quarter Infection Rate (QIR) from 30% to 10%. With butter fat price at 50¢ per lb., $2.10 per cwt.

Benefit from Yield Increase	= $1,155 per 100 cows
Benefit from Better Cow Disposal Pattern	= 171 " "
Benefit from Additional Yield Increase due to increase in herd age	= 450 " "
Benefit from Reduced Cost of Treating clinical cases	= 60 " "
Total Benefit	$1,836

Net Gain – Total per 100 cows

Benefits	$1,836
Costs	446
Net Gain	$1,390

i.e. about 300% return on investment.

Net Gain – Per 1% reduction in Q.I.R.

Gain is $13.90 per cow. For reduction of 20%, i.e. 70¢, per 1% reduction in quarter infection rate expressed as net gain per cow.

They are based on our field research, and show the usual response in terms of additional milk yield and reduced cost of clinical mastitis. In addition, we have preliminary evidence to suggest that effective mastitis control will increase the productive life of cows, thus saving money on replacements and boosting herd yield because the cows are older and producing closer to their peak potential. When the calculations are carried out for a herd of the type we are dealing with, you can see that the net return from our program, including the veterinary component, is $1,390 per 100 cows, which is about 300% return on invested funds.

You will note that we have not charged any labor costs for the farmer—this is because they are very variable and usually small or often non-existent—for instance, in many herds milking time is not at all prolonged by the introduction of teat dipping. However, it would be very easy to adjust the financial figures to include a labor cost for herds where this was significant.

When we apply these figures to the 500 cow dairy I will be using as my example in later papers, we find that the estimated gain for mastitis control is a reduction of 31 percentage points in the Quarter Infection Rate, which represents a net gain over the baseline year of $11,501. As I will explain

Table 4

Costs and Benefits of Mastitis Control

Example. Herd milking 530 head (mean herd size over 4 years).	
Mastitis Quarter Infection Rate 1968.	42%
Mastitis Quarter Infection Rate 1973. (1969-28%; 1970-18%; 1971-27%; 1972-16%)	11%
Reduction in Q.I.R.	31%
Net Financial Gain for 530 head	530 x 31 x 70
in 1973 over baseline 1968	100
	$11,501
N.B. The net gain by the infertility program in the same herd estimated similarly	$ 8,083
Mastitis plus Infertility Programs. Total Net Gain	$19,584

later, the net gain from the infertility program is estimated at $8,083, making a grand total of $19,584, which is approximately $38 per cow (Table 4).

In Australia, this is a very handsome return in anybody's language. There are of course problems, at least two, with results presented in the above form. *Firstly*, they are not expressed in the concrete, positive, statistically significant, treatment-versus-control group form generally required as proof by scientists/academicians/opponents.

You will know how difficult it is even with the best will in the world to combine an experiment with a demonstration using a commercial herd which keeps most of the records, which for labor or other reasons relaxes the severity of its control techniques, and then renews it under stimulation by us. We simply have to accept these fluctuations in herds with whom it is necessary to maintain a close, cooperative relationship.

We have to accept coarse trends and indications of the course of events. Statistically significant means and standard deviations are just not available. And even before and after, comparisons present great difficulties in organization.

The figures I have given you are representative rather than highly accurate.

The *second* problem with the results relates to the financial figures I have used. They are estimated, accurately I think, from known cost and benefit data in our own area. It is a partial budgeting exercise and quite acceptable as a technique to economists. My more pragmatic veterinary friends would prefer to see a total farm budget. They would prefer to see whether an individual farm did in fact become more profitable and if so, how much we contributed to it. We would prefer to do the same thing, but even if we did know the full income figures for each farm, it would be impossible to determine what part of the change in income from year to year were caused by us and what part by inflation, or feed costs, or price of labor. Given enough cows in enough herds we could do it. I have an open offer by an economist who has offered to provide the analysis if I can provide information from 30,000 cows.

We are reduced then to knowing that numerically we have gained an advantage. This gain multiplied by the usual biological gain in production shown by ourselves and others in controlled studies, and then multiplied by the *value* of the gained production gives us an accuate estimate of the extra money earned.

The total cost of resources put into making the gain is not hard to measure, and hey, presto, we have a net gain, which will of course vary between areas, depending on the value of the labor input and the value of the product output. We have checked the basic principles of this approach and all the evidence suggests that the estimates are satisfactory.

Using conservative estimates, we figure that the return to capital invested is usually of the order of 300 to 500%. This is an exceptionally good return on most capital investments in agriculture in our country, which are usually of the order of 15 to 20%.

The fact that they are so high does not disturb us too much because the estimate is almost exactly the same as that derived quite independently by the Canadians in their assessment of the overall yield from a total herd health program.

That is all I have to say about mastitis control. I hope I have made my central point clear. It is *not* that mastitis can now be strictly limited in its prevalence. That is abundantly clear. The central argument is whether practicing veterinarians participate in this control program.

It is not essential that they do, and unless they express interest in participating in the work, they can be eliminated from this section of preventive veterinary work.

My point is that a strong argument can be made for the need for veterinarians to be involved in mastitis control on the grounds of the financial gain which can be achieved. I am open to conviction that it can be done better and cheaper some other way. One thing I am sure of, and that is that if veterinarians do not express their willingness to participate in mastitis control, whether they really like it or not, and I have to accept that many do not, they will, in effect, discard one more support of the bovine practitioner.

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*Genera *Trichostrongylus* sp, *Haemonchus* sp, *Nematodirus* sp, *Ostertagia* sp, *Oesophagostomum radiatum*, and *Cooperia* species

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