*Methods of Mastitis Control

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Introduction

Mastitis control is a worthy goal. This conclusion is inevitable when one considers that bovine mastitis reduces both the quantity and quality of milk, that milk production costs are rising in most countries, and that many developing countries have a milk deficit. The disease results from complex interrelationships between the cow, a host of pathogenic microorganisms, and myriad epidemiological factors.

While mastitis occurs at different levels of severity, individual cases may be defined for convenience as **clinical** or **subclinical**. For each case of clinical mastitis in a population of herds, there will be 15 to 40 subclinical cases, and most clinical cases are preceded by infections at the subclinical level.

The disease is best viewed as a herd problem rather than an individual cow problem, particularly from the standpoint of control. A control program should increase economic returns, be highly effective in most herds, reduce new infections, shorten the duration of pre-existing infections, provide tangible evidence that clinical mastitis is reduced, and be subject to easy modification as improved components are evolved.

Aside from a reduction in level of infection with *Streptococcus agalactiae*, there is little evidence of progress toward mastitis control over the past 30 years. The inescapable conclusion is that either existing control programs are inadequate or they have not been applied effectively.

When mastitis control is left to the initiative of dairy farmers, most elect to follow a program of **no control.** Dairy farmers are loathe to implement control programs because of the inconspicious nature of the disease and the fact that most are accustomed to living with it. Too, the microbial world is an unfamiliar dimension to most dairy farmers and many are confused regarding control methods because of conflicting advice from different sources. Primary justification for mastitis control is economic. Failure to achieve wider adoption of control methods indicates that research and advisory personnel have not been desirably effective in diffusing information and motivating dairy farmers to adopt control procedures.

The dynamics of the disease and epizootiological considerations have been reviewed previously by Tolle (1975), Morse (1975), and Dodd, et al. (1977). The objectives of this paper are to consider alternative control methods, reasons why the methods are not more widely adopted, and procedures for enhancing adoption. The basic prerequisites for mastitis control are **evoluation of technology** and **diffusion and adoption of technology.**

Evolution of Technology

Infection Levels

In devising programs of mastitis control it is necessary to distinguish between **incidence** and **level** of infection. Incidence relates to **rate**; whereas, level relates to percent quarters or percent cows infected and is a function of both **rate** and **duration** of infection.

It is impractical to measure rate of infection in dairy herds. Progress in mastitis control must be determined by either a direct or indirect measurement of infection level. The direct method involves laboratory analysis of aseptically collected milk samples and has not been widely adopted due to the high costs of trained personnel and laboratory facilities. The indirect method involves the cytologic examination of milk to detect products of inflammation, viz., somatic cells.

The somatic cell count is the most useful parameter available for estimating levels of infection in a herd, preferably on a moving geometric mean basis. Somatic cell levels are a function of both the percent of quarters infected and infection severity. While some variation exists among herds in the correlation between somatic cells and level of infection, there is almost invariably a decrease in infection when emphasis is placed on reducing cell levels. Furthermore, a negative relationship exists between somatic cells and most milk production.

Alternative Control Methods

In selecting a control program it is necessary to define the objectives; two basic approaches are available.

The first involves diagnosis and eradication of specific pathogens. This procedure requires extensive use of trained personnel and support facilities and generally is recognized as too expensive for international adoption. The approach has been used successfully in Scandinavia, particularly in Denmark

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where the program is subsidized by the government (Olsen, 1975). Emphasis is placed on detection and eradication of *S. agalactiae* and success of the program is evidenced by only 1% of cows being infected with that pathogen. Unfortunately, 35% of cows remain infected with other pathogens and the level has decreased very slowly which emphasizes one of the deficiencies of concentrating a program on only one pathogen. Teat dipping and dry cow treatment are not practiced widely because of concern for residues and resistance. Danish legislation stipulates that antibiotics may be administered to animals only by veterinarians. This practice has indisputable advantages but is clearly impractical in countries where dairying is less intensive.

The second and more practical approach to mastitis control advocates adoption of management practices that are applicable to all dairy herds without knowledge of either specific pathogens or which quarters are infected. A primary objective is to reduce the number of components in the control program to a minimum. Such programs should not be directed exclusively to herds with a high level of infection because the greatest benefit will be derived from the majority of herds which have an average infection level.

Dodd and Neave (1970), at the National Institute for Research in Dairying (NIRD) in England, have made a significant contribution to the strategy of mastitis control. They demonstrated that a program based upon diagnosis, treatment, and culling could reach only a minority of herds and would, therefore, be of limited value in reducing overall levels of infection in a large population. As an alternative, programs were developed that reduced new infections and shortened the duration of existing infections. The success of the program is well known to most workers in the field. Disadvantages of the NIRD approach include cost, hesitancy of dairy farmers to adopt additional procedures, concern over increased risk of infection with environmental pathogens, and the possibility that farmers might place too much reliance on teat dipping and dry cow therapy to the neglect of other elements of management that are of epizootiologic importance.

The essential components of a mastitis control program that has prospects for international adoption are: 1) correct use of functionally adequate milking machines, 2) effective hygiene with emphasis on post-milking teat antisepsis, 3) prompt treatment of clinical cases, 4) treatment of all quarters at drying off, and 5) culling of animals with refractory infections. Each of the five points is discussed briefly.

1. Milking Machines and Methods. Recent experiments on the milking machine have provided welcomed information regarding the pathogenesis of certain infections, particularly those that may be machine mediated as a result of vacuum fluctuation, careless handling of units by operators, presence of liner slips, and removal of units from the teats while under vacuum. Each of these factors may interact with other factors and cause infections. Machines should be analyzed at least once annually by qualified service personnel and gross defects corrected.

2. Hygiene. The incidence of intramammary infection is positively correlated with the number of pathogens impinging on the teat apex. Practices that minimize pathogens on teats usually reduce infection incidence, and the most effective single hygienic practice is dipping teats in a suitable disinfectant following removal of machines. The practice is more efficacious against pathogens spread during the milking act, i.e., *S. agalactiae* and *Staphylococcus aureus*, than against pathogens of environmental origin.

3. Treatment of Clinical Mastitis. Basing a control program on treatment of clinical mastitis is an exercise in futility because only about 40% of infections are detected during lactation. Moreover, response is low and effect on overall level of infection is negligible. A major problem with antibiotic therapy is that practically all clinical cases **appear** to respond to treatment and many dairy farmers defer use of other control methods because of a false reliance on therapy. For best results, clinical cases should be treated promptly with a full series of treatments administered with aseptic precautions.

4. Dry Cow Treatment. The initial success of a control program, in reducing infection level, is dependent upon reducing duration of pre-existing infections. The preferred therapy for most subclinical infections is treatment of all quarters of the udder at drying off with a high persistency preparation. Advantages are as follows: 1) the cure rate is higher; 2) new infections in the dry period are reduced; 3) damaged tissue may be regenerated; 4) clinical mastitis at parturition is reduced; 5) salable milk is not contaminated with drug residues; 6) it is a once-a-year event, and 7) all infected quarters receive treatment; whereas, selective drying off therapy results in about half of the infected quarters remaining untreated.

5. Culling. Culling is a useful tool for ridding a herd of refractory infections.

Problem Herds

Only a minority of herds fail to respond to the five-point program. Reasons are complex and causes are sometimes difficult to identify. Conditions frequently observed in such herds are poor hygienic practices, defective housing, malfunctioning machines, improper milking methods, and inadequate therapy procedures. It is folly to recommend to a dairy farmer, whose milk permit has been revoked because of excessive somatic cells, that he initiate only teat dipping and dry cow treatment. Though these practices should be implemented, the urgency of the situation requires that additional action be taken such as correcting defects in milking machines, improving milking methods and herd environment, treating selected animals during lactation, and culling those where the prognosis is poor.

Failure of a minority of herds to respond to a control program argues for redundancy in control methods, particularly in terms of preventive components. Thompson (1977) reported that one of the problems of attempting to optimize management practices is that individual causative factors may have several effects and in some instances contradictory ones. With most aspects of the mastitis problem, improvement is not obtained by maximizing an individual factor but by setting a value which is a compromise between what would be optimum for each of a number of operational characteristics.

Diffusion and Adoption of Innovations

Workers in the mastitis field have pursued, with vigor, the evolution of technology but have treated, with benign neglect, the subject of why mastitis control methods are not more widely adopted. Seemingly, we have been guilty of assuming that the **generation of knowledge** was synonymous with **diffusion and adoption of knowledge**. The mechanics by which innovations are diffused and the social attitudes affecting the adoption process need to be understood better if higher adoption rates are to be achieved. Social change among farmers has been studied extensively by sociologists (Beal, *et al.*, 1966).

Diffusion is the process by which information spreads geographically, and final **adoption** of new or improved practices is a complex process that is dependent upon many interrelated personal, cultural, social, and situational factors. It very seldom just "happens" but normally is a carefully conceived and planned process, the requirements of which should not be oversimplified. For example, diffusion of an idea and diffusion of a practice are not synonymous, though the former always precedes the latter.

The Adoption Process

The adoption process involves an interrelated series of mental activities rather than a single act and includes five distinguishable stages (Beal and Bohlen, 1968; Bertrand, 1973; Lionberger, 1960; and Rogers and Shoemaker, 1971).

1. **Awareness.** The farmer learns about an idea or practice but lacks complete information.

2. **Information.** The farmer becomes interested in the idea and seeks further knowledge. His interests include why and how it works, how much it costs, how it compares with other practices purported to perform similar functions, and resources required to obtain optimum benefits.

3. **Evaluation.** The newly obtained knowledge is mentally examined and the alternatives are weighed in terms of established goals before deciding whether or not necessary resources are available to permit a trial examination. The farmer often wants to know what others think, particularly those who have tried it locally.

4. **Trial.** The idea is used on a small scale to determine utility.

5. **Adoption.** The decision is made to initiate full use of the idea.

Characteristics of innovations affect the rate of adoption. Some of those that promote more rapid adoption include simplicity, visibility of results, compatibility with existing practices, perceived usefulness for meeting an existing need, degree to which the innovation can be tried on a limited basis, absence of undesired side effects, low capital investment, and ease of communication (Bertrand, 1973; and Rogers and Shoemaker, 1971).

The community adoption curve has several features as shown in Figure 1. There is a slow, gradual start followed by acceptance at an increasing rate and, finally, by acceptance at a declining rate after most persons have adopted (Beal and Bohlen, 1968; and Lionberger, 1960). Farmers may be categorized according to the rate at which they adopt new ideas.

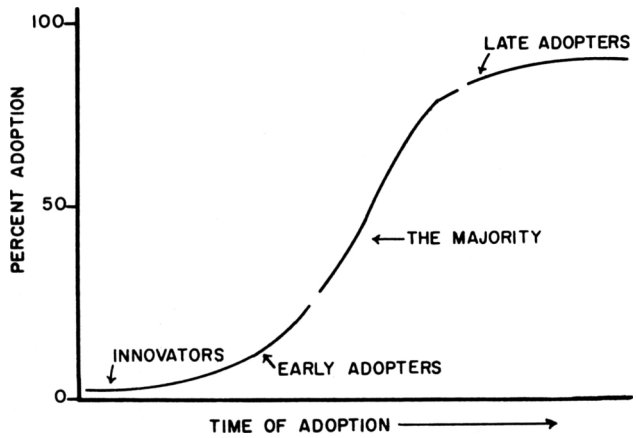

FIGURE 1. THE COMMUNITY ADOPTION CURVE.

1. **Innovators.** These are the first to adopt. They tend to be adverturesome and have a desire to try new ideas even if it means an occasional failure. Small communities probably have only two or three such farmers. They tend to have larger farms, higher net worth, and more risk capital. Often they have high prestige, are from well-established families and are active in formal organizations beyond their community. Most receive their information directly from researchers and they subscribe to many magazines and journals. They legitimize the innovation in the minds of other farmers who are watching.

2. **Early Adopters.** These farmers have a higher education than slower adopters and participate more in cooperative and government programs in the community. They are viewed as leaders and read more publications than those who adopt later.

3. **The Majority.** Those in this group are older than early adopters, are less active in organizational work, and read fewer publications.

4. **Late Adopters.** These tend to be older, have the smallest farms, have the least education, participate the least in formal organizations, read the fewest publications, and are reluctant to adopt new ideas, especially those introduced by "outsiders." They de-

pend primarily on other farmers for information. This group confirms the truth of the old adage that "those who need advice the most tend to like it the least."

Communication

Communication is the means by which knowledge of new innovations is diffused, and always precedes adoption. Research and advisory personnel should consider more seriously their potential role as **change agents** who can influence adoption decisions. Workers in different disciplines should work cooperatively to transcend interdisciplinary jealousies that impede adoption of mastitis control methods. Concern for protecting personal proprieties is often counterproductive to the adoption process. Moreover, those of us in technical research should not feel that our responsibilities are fulfilled when experiments are completed and technical manuscripts published. The findings must be diffused more widely and the potential significance of the work may not be readily perceived by advisory personnel already preoccupied with other duties. In most instances improved use can be made of paraprofessional personnel such as artificial breeding technicians, drivers of bulk milk trucks, technicians for dairy cooperatives, and representatives from the commercial sector. These workers usually contact dairy farmers on a one-on-one basis, and it is imperative that they be properly informed.

Guidelines for promoting acceptance of new ideas include the following (Lionberger, 1960).

1. Use mass media to inform clientele about new ideas and create interest. This is particularly important in the first phase of community adoption.
2. Facilitate communicative exchange among people about innovations. This accounts primarily for the rapidly accelerated portion of the community adoption curve.
3. Select communicators who are both informed and acceptable to the clientele. Personal acceptability of the communicator is sometimes an absolute prerequisite for farmer acceptance of advice.
4. Plan and conduct special, promotional programs for innovators. If they cannot be readily identified, many can be reached by aiming mass media messages at an intellectual level above the average. These persons are then more apt to attend meetings where new ideas may be presented.
5. Insure success of new ideas by innovators and early adopters. These persons are being watched and their failure will impede continuity of the diffusion and adoption process.
6. Enlist help from commercial **change agents.** It is important to recognize that some commercial representatives may be less than desirably effective because dairy farmers perceive them to have a vested interest.
7. Pretest educational materials, before large-scale introduction, to determine if modification is needed. In some cases, the materials will not convey the intended message to the target audience.
8. Reinforce decisions already made. Some farmers may stop using a practice unless they are continually reassured that it is sound. Practices of high utility may be abandoned for unsound reasons.
9. Set realistic goals. Setting the stage for accelerated acceptance at a subsequent time may be better than trying to achieve a high degree of adoption initially.

Change agents are often more effective if they concentrate on improving the competence of the farmer in evaluating new ideas than in promoting the idea directly. For example, if the farmer is convinced that mastitis control **will return a profit,** he is more likely to be interested in details of **how** to control the disease. In the early stages of introducing an innovation, maximum effort should be focused on opinion leaders, because they will help to diffuse information and enhance adoption.

Mein, *et al.* (1977), recently reported results of personal interviews with 1,000 dairy farmers in Australia. An assessment was made of the perception and knowledge of mastitis and the level of adoption of mastitis control practices. Most farmers were reported to have little or no awareness of subclinical mastitis as a herd problem. Only 23% dipped teats, and only 26% used correct drying off strategy. The farm press, veterinarians, and neighbor farmers were regarded as the major sources of information about mastitis.

At a recent meeting with the board of directors of a large dairy cooperative in the United States, the author asked the question, "How can dairy farmers be motivated to adopt mastitis control methods?" The unanimous consensus was that it is necessary to **create a need in the mind of the dairy farmer.** Two options were suggested for attracting immediate attention, viz., **incentive payments** or **punitive regulations.** Additional motivation might be provided if dairy farmers requiring use of expensive field specialists and laboratory services were charged the full costs of these services rather than having the costs shared with progressive farmers who adopt recommended control programs and do not require the services.

Though a somatic cell count is an imperfect tool, it serves a useful purpose in encouraging adoption of mastitis control methods, particularly when combined with an incentive payment program that includes other milk quality parameters. Incentive payments are more widely used in Europe than in North America.

Summary

Mastitis control is a continuing process that should be applied to all herds without relaxation. Programs likely to achieve widespread adoption must emphasize **control of all pathogens** rather than **eradication of specific pathogens.** Though none of the methods available at this time provide complete protection, the devastating losses from mastitis can be minimized with current technology in the vast

majority of herds. A control method similar to that developed at the NIRD in England has the greatest utility. The program is not dependent upon examination by specialists, can be applied to any herd, is effective against common pathogens, results in a profit, and is flexible to permit refinement as additional knowledge becomes available. Failure of the NIRD approach in herds, that seemingly are well managed, is often due to failure of the farmer to apply the methods properly. In some instances the farmer may perceive that he is following a recommended control program when, in reality, he is following only a part of the program. Overlapping and complimentary components are of greatest value. Control methods that aim at a particular organism are highly dependent upon advisory personnel and supporting laboratories and have little chance of reaching a majority of dairy herds.

Continuing research on mastitis will result in further improvements in the components of a mastitis control program. A prospective advancement on the horizon is enhancement of spontaneous elimination of infections by eliciting a more efficient defensive mechanism within the animal, e.g., by the use of opsonins or complement to enhance phagocytic activity. In the meantime, there is a need for increased emphasis on motivational research and the attitudes of dairy farmers which affect their adoption of new innovations. To achieve greater adoption we must appeal to the dairy farmer's professional pride, conscience, and other faculties to strengthen his self-confidence. We should remember also that "repetition is the mother of learning," and the failure of dairy farmers to adopt recommended control practices indicates that those of us with research and advisory responsibilities must intensify our efforts. By working together as a team, we can, and will, effect wider adoption of mastitis control methods. Only then will we have fulfilled our responsibilities to the dairy industry and the consuming public.

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