Mastitis Newsletter aims mainly at disseminating succinct information on the work, plans and achievements of the IDF Standing Committee on Animal Health relating to Bovine Mastitis, but also includes information available to the Group from other sources such as the National Mastitis Council (NMC) in the USA. The Standing Committee and the NMC have a close working relationship.

Mastitis Newsletter does not intend to review systematically the vast literature in the field of mastitis nor does it claim to report on all significant developments in the field.

Information given and statements made in Mastitis Newsletter do not commit IDF. They can be reproduced, with indication of source.

Contributions dealing with items of general interest would be welcome for consideration for inclusion in future issues.

Mastitis Newsletter is available from International Dairy Federation (IDF), General Secretariat, Diamant Building, Boulevard Auguste Reyers, B-1030 Brussels (Belgium). It is produced in English only and it is expected to be of interest to persons studying the many aspects of mastitis, to veterinarians, research institutes, students, etc.

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Report of the IDF Standing Committee on Animal Health

Members of the Standing Committee on Animal Health are responsible for the Mastitis Newsletter. The very capable editor of the Mastitis Newsletter is Dr. Henk Hogeveen, Department of Farm Management, Wageningen University (NL) and SCAH thanks him for the tremendous amount of work he puts into the newsletter. While mastitis control and its impact on milk quality and safety is a major work area for SCAH, other health issues are receiving considerable attention. During the past year SCAH has dealt with BSE, Johne's disease, and Foot and mouth disease. Members have also been actively involved in providing input to requests from PCC regarding the Codex Draft Code of Hygienic Practices for Animal Milk Production, the Task Force on Codex Export Certificates, and the Task Force on Good Farming Practices. A symposium entitled 'A Fresh Perspective for Managing Milk Born Diseases' was organized for the IDF Annual Sessions in New Zealand. Leadership for this effort was by Dr. Gwyn Verkerk (NZ). The proceedings will be published in the IDF Bulletin and are on CD and available from IDF Brussels.

The programme of work for SCAH over the past year has included several items directly related to bovine mastitis and a brief summary of the work of these Action Teams follows. The Action Team on Abnormal Milk produced a document entitled "A Discussion on Normal and Abnormal Milk I. Somatic Cell Counts and Signs of Clinical Mastitis". There was no consensus approval of the document and the document was not published as a work item by SCAH. This Action Team was disbanded. The information in the article and the opposing view were papers presented in the Animal Health Symposium at the Annual Sessions in New Zealand and they can be found in the proceedings of that meeting.

The Action Team on Antibiotic Therapy, led by Dr. Eric Hillerton (UK), has produced a draft document entitled "Intramammary antibiotic therapy in the non-lactating dairy cow, known as dry cow therapy". It is hoped that the draft will be approved and published in the IDF Bulletin by the fall of 2002. There is also a Task Force on Economics led by Dr. Olaf Østerås (NO). The objective of the Action Team is to produce a document that will provide a basis for determining the global economic cost of bovine mastitis. The target date for completion is early 2003.

The most recent meeting of SCAH was in Orlando, Florida and preceded the annual meeting of the US National Mastitis Council (NMC). Several members of SCAH are members or Chairs of important committees of the NMC and are often invited speakers at the NMC annual meeting. Both NMC and IDF SCAH have agreed to continue to communicate regarding areas of mutual interest. The Orlando meeting of SCAH was also used for a brain storming session regarding the future work of SCAH and the best methods for conducting that work. The session was led by Dr. Laura Kulkaas (FI) and those present found it to be worthwhile. A written report will be available in the coming months.

The SCAH is proposing to hold an international mastitis seminar in the year 2005. This seminar would represent the forth in a series of major IDF sponsored seminars. These particular seminars have been comprehensive in scope and have attracted participation from nearly all countries with an interest in the control of mastitis on dairy farms. The seminars have served as an important vehicle to disseminate information to emerging dairy nations. Previous seminars were in Reading England, 1975; Kiel, Germany, 1985; and Tel Aviv, Israel, 1995. At this time, it would appear that the 2005 seminar will be held in The Netherlands. The exact time and place are still being negotiated. Future meetings of SCAH will be Friday, 20 September 2002 in Paris (FR) in conjunction with the IDF annual sessions and 25-26 January 2003 in Fort Worth, Texas.

K.L. Smith, Chairman
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Note from the Editor

The Mastitis Newsletter: Ongoing overviews of mastitis work in the world

Within the IDF Standing Committee on Animal Health, mastitis remains a subject of wide interest. We are therefore pleased to present a new issue of the Mastitis Newsletter. The objective of the Newsletter is to give a view on current issues relating to mastitis on a worldwide basis. It does not aim at being complete or exclusive, but at giving insight into past and future meetings and some research items. In this issue there are some interesting research communications on subjects such as milking frequency, automatic milking and somatic cell count in relation to other milk constituents. There are two contributions from the cutting edge of science: PhD research. There is also a large number of contributions with regard to future and past meetings. Finally I would like to draw your attention to two special contributions in remembrance of Frank H. Dodd. A great research worker and educator, whom I unfortunately only know from his many scientific papers. Others from the Standing Committee on Animal Health have been very lucky enough to have worked together with Frank H. Dodd. K. Larry Smith has written an "In Memoriam" and J. Eric Hillerton has provided us with a paper of Dr. Dodd to remember some of his work.

The Mastitis Newsletter would not exist without the input of many colleagues who are willing to spend some of their valuable time to contribute to the Newsletter and I take the opportunity to thank them for their willingness.

To all of you, if you have announcements, meeting reports, mastitis information or short research communications to share, we invite you to submit them to the Mastitis Newsletter

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THE COMMUNITY OF MASTITIS RESEARCH WORKERS AND EDUCATORS HAS LOST A GREAT COLLEAGUE

The recent passing of Dr. Frank Dodd provided the opportunity for many of us who have spent our productive careers working on mastitis control, the opportunity to reflect on how truly great Dr. Dodd’s contributions were. I remember meeting Dr. Dodd for the first time as a young graduate student in the late 1960s at the Ohio Agricultural Research and Development Center. Dr. Dodd was the guest of Dr. Bill Pounden (OARDC) and presented a seminar on mastitis control. That seminar was a major factor in clarifying my research interest and subsequently, the direction my career would take.

In the late 1970's, I had the opportunity to visit Reading and spend one month with Dr. Dodd and the group at the National Institute for Research in Dairying, Reading, England. I was by no means unique in visiting Reading and only followed a long list of mastitis research workers including several from the US. But he treated me as though I was the first one ever to pay such a visit and I felt honored when he invited me to have dinner with him and Mary. He spent the evening patiently educating me in the dynamics of mastitis in dairy herds and how truly important the dynamics of the disease were to design of effective control procedures. The classic field studies (MFE-1, MFE-2, and MFE-3) are still the basis for mastitis control schemes in many countries around the world. While a host of individuals, most well known in their own right, helped to make this series of field trials a scientific success, Dr. Dodd was clearly the glue that held the team together and gave it focus.

I also remember that trip and time spent in Reading as my first real encounter with the International Dairy Federation and the A2 Group of Mastitis Experts. During the month in Reading several individuals from other European countries came to visit and have discussions with Dr. Dodd and many of those discussions involved matters being addressed by the IDF A2 Group. Dr. Dodd was Chair of A2 and the membership clearly had great respect for his views on mastitis control and his leadership of the A2 Group. Little did I know that I would some day follow in his footsteps and become Chair of A2. I consider it one of my highest honors to be able to say that I had the opportunity to Chair the A2 Group that was lead so successfully for so many years by Dr. Dodd.

My sincere sympathies go out to Dr. Dodd's family in what is truly a sad time. However, it is also a time to celebrate a great man and a great scientist. I am thankful for the time I got to spend with Dr. Dodd and I will miss his wisdom, his warm smile and wonderful sense of humor.

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(Paper prepared for the “Seminar on Dairy Production” in honour of Professor C O Claesson, Swedish University of Agricultural Sciences, Uppsala, Sweden. December 1987)

BOVINE MASTITIS – THE SIGNIFICANCE OF LEVELS OF EXPOSURE TO PATHOGENS

F.H. Dodd,* Curridge, Newbury, England

There can be few problems in dairy science that have been as extensively researched as bovine mastitis. By the mid-1930s about 3000 published papers were included in a literature review [1] and because the research has continued the Commonwealth Agricultural Bureau has found it necessary to publish an Annual Mastitis Literature Survey [2]. This literature demonstrates the extent of the understanding of this complex and economically important problem. It is not a single disease but an inflammation of the mammary gland, though this is nearly always caused by microbial pathogens. Five bacteria (Staphylococcus aureus, Streptococcus agalactiae, Streptococcus dysgalactiae, Streptococcus uberis, Escherichia coli) account for more than 90 percent of all infections but many factors influence the probability of an infection. These may be genetic, either bovine or microbial, but physiological factors such as the age of the cow and its natural resistance to infection are also important. In addition, there are many environmental influences and these are almost certainly the major reasons for the huge differences in the patterns and extent of the mastitis problems in individual herds. The research has not led to a simple method of control by eradication, immunisation or therapy, but there are now control methods, based on management techniques coupled with specific ways of

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intramammary therapy, that have proved effective. They are capable of reducing levels of infection in herds by at least 75% [3]. Nevertheless in spite of this progress there are many aspects that are not fully explained not the least of which is the marked variation in the pattern of infection between herds and the fact that current control methods are not effective against all types of pathogen. In this paper aspects of the variation in the patterns of infection in herds are examined. The analysis demonstrates the important affect of the level of exposure to pathogens not only as it affects the rate of infection but also the relative importance of different pathogens in individual herds. It also indicates lines of research likely to lead to improvements in the control of the disease.

A useful starting point in examining the importance of exposure to infection is the fact that cows have a remarkably effective resistance to intramammary infection and that most of this resistance lies in the teat duct as a barrier to the penetration of pathogens. This can be demonstrated by a simple comparison. In herds where no hygiene is practiced the teat ends will be constantly contaminated with mastitis pathogens yet the probability of an uninfected quarter becoming infected in a single milking interval is of the order of 0.003 [4]. Yet if 10 colony forming units of a mastitis pathogen are infused beyond the teat duct on one occasion the probability of infection usually exceeds 0.5 [5]. It is not surprising that cattle have developed this degree of resistance to infection in the course of their evolution. Only cows that could resist the constant challenge of mastitis pathogens would successfully lactate and be able to nourish their young.

If the main resistance against infection is the ability of the teat duct to prevent bacterial penetration then it is probable that there is a relationship between the frequency of infection and the level or dose of exposure to pathogens. There is substantial evidence that such a relationship exists:

- reducing levels of infection in herds results it lower subsequent rates of infection [7]
- rates of new infection in completely uninfected udders are much lower than in uninfected quarters of udders with at least one infected quarter [8]
- infection rates are increased when teat lesions colonised by mastitis pathogens are common [9]
- when a particular herd environment encourages the multiplication of an uncommon mastitis pathogen outbreaks of atypical infections occur [10]
- data from artificial exposure experiments indicate a relationship between the number of bacteria in the exposure suspension and infection rates [11] and that by increasing the exposure to high levels the rates of infection achieved are much greater than those normally occurring in herds [12]

It is important to recognise that not all of these observations demonstrate a direct relationship between new infection and level of exposure but in total they give strong support that there is a causal relationship. This makes it surprising that research on this aspect of the mastitis problem has been so neglected, particularly when the control systems used in most countries are based on management methods of reducing exposure to pathogens.

Some of the most interesting detailed work on exposure was by Neave [13,14] in the pioneering work leading to the reintroduction of disinfecant teat dips, and by Bramley [15, 16] on the effect of exposure to the so-called environmental pathogens.

From the results of extensive measurements from swabs of teat skin and teat ducts Neave drew the general conclusion that "staphylococci and streptococci do not normally persist on healthy teat skin and their presence indicates recent contamination...." [14]. Furthermore, although the spread of mastitis pathogens from milk on hands and milking equipment cannot be prevented the numbers of pathogens found on the healthy skin of the teats of uninfected quarters will normally be small if they do not have colonised ducts. In fact even in herds with above average levels of staphylococcal infections the pathogens are not detected from over 50% of the swabs of teat skin even in herds not using disinfectant teat dips [14, 17].

Table 1. The recovery of S. aureus from cows teats free from lesions but milked at the preceding milking after a cow infected with S. aureus. Teats were either dipped in one of 3 concentrations of sodium hypochlorite or undipped [14]

<table>
<thead>
<tr>
<th>Teat dip</th>
<th>No. swabs</th>
<th>% teats contaminated</th>
<th>No. swabs</th>
<th>% teats contaminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not dipped</td>
<td>129</td>
<td>94</td>
<td>206</td>
<td>38</td>
</tr>
<tr>
<td>Hypochlorite conc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1%</td>
<td>15</td>
<td>93</td>
<td>129</td>
<td>15</td>
</tr>
<tr>
<td>1.0%</td>
<td>11</td>
<td>91</td>
<td>84</td>
<td>10</td>
</tr>
<tr>
<td>4.0%</td>
<td>-</td>
<td>-</td>
<td>29</td>
<td>4</td>
</tr>
</tbody>
</table>
depend primarily on the extent that teat skin and ducts are colonised and not through the regular contamination of teats with milk from infected quarters transmitted during the milking process. There will of course be exceptions to this. Occasionally the milk from a clinically affected quarter will contaminate the teat skin and ducts of milking cows which will be grossly contaminated from the milking equipment.

The importance of these observations stems from the fact that teat skin lesions occur in all herds and, under some environmental conditions, are common [13,14,20]. In some herds in winter nearly all the cows will have chapped skin on the teats (that is, skin fissures due to loss of skin elasticity) and the severity of the lesions and other lesions is exacerbated by housing under muddy conditions, teat tramps' and the damage caused by biting flies. Furthermore in herds not using post-milking teat disinfection up to 70% of the teat ducts may be colonised by S. aureus [14].

The measurements of the epidemiology of mastitis suggest that the principal way that post-milking teat disinfection reduces new intramammary infection is by reducing the bacterial colonisation of teat lesions and teat ducts, and that their effect on the inevitable adventitious spread of pathogens during milking is of much lesser importance. Evidence from field experiments indicates that when effective teat disinfectants are used the teat lesions are considerably reduced and healing is more rapid [21, 22] and that, when 4% hypochlorite is used, colonisation of teat ducts by S. aureus is almost eliminated [14]. Although teat chaps are the most refractory of lesions they too respond well to disinfectant dips or sprays containing an emollient [21]. Further support for this general hypothesis is provided by the evidence that teat disinfection has a major effect only against pathogens that colonise teat skin and ducts (S. aureus, Str. agalactiae, and Str. dysgalactiae) and is ineffective against those pathogens that do not normally colonise teat skin, for example, E. coli and Str. iberis.

Published data published on the aetiology of Str. iberis and E. coli indicate that outbreaks of these infections are often associated with marked increases in exposure to pathogens though the reasons for this are quite different from staphylococcal infections. Swabs of the teat skin under commercial conditions indicates that E. coli and Str. iberis are widespread but the numbers recovered are usually small and unaffected by teat dipping and other milking time hygiene [13,16]. Nevertheless clinical outbreaks with these pathogens are not uncommon and usually occur with housed animals or cattle concentrated in small paddocks. Under these conditions the exposure to pathogens can reach very high levels. Str. iberis multiplies readily in straw bedding and, with E. coli, this occurs when sawdust is used [15,16]. A striking example of this has been the evidence of the concentration of E. coli in the sawdust bedding where the udder touches the ground and milk leaks from the teat. The concentration of bacteria sometimes exceeds 10^6 cfu/g of bedding material, a level which can be one thousand times greater than that of cow dung. It is not surprising that under these conditions outbreaks of E. coli mastitis occur [23].

The role that the milking machine plays in modifying exposure to pathogens is secondary, but can be important. Obviously milking machines play a major role in transmitting pathogens from cow to cow during milking. Whilst the concentration of pathogens in the milk will usually be small. This is a primary source for infecting teat ducts and lesions. Transfers in this way can be prevented by pasteurising the milking machine cluster before each cow is milked but the modest benefit that this gives compared with teat disinfection alone has not been considered economic for general adoption [14]. The transfer of pathogens through the milking machine to uninfected quarters of an infected udder will be relatively much higher and will account to some extent for the higher rates of infection of these quarters. This spread of bacteria cannot be prevented by pasteurisation method described above but can be almost eliminated by redesigning the milking machine cluster [24]. Considerable attention has been given to the increase in bacterial exposure to the teat duct by the 'reverse flow' of the milk during milking [25]. The impact of contaminated milk on the teat end is a mechanism by which infection rates are increased though their effect can be prevented by modification of the teat cup liners or claws [24,25].

Most recent research on the effect of milking machines on infection has been on the way that they transmit pathogens. But milking machines can cause structural damage to teat skin, particularly to the external orifice of the teat duct, the skin where the mouthpiece of the liner is in contact with the teat during milking [14] and skin haemorrhages near the teat end due to the effects of vacuum [20]. This damage will encourage colonisation of teat skin by the commonest mastitis pathogens and if post milking disinfection is not used the effect is likely to be considerable. Unfortunately there are no data on the direct effects of different milking machine factors on the bacterial colonisation of teat ducts. However, it is interesting that in the studies of 'linerless milking' the increased rates of infection were associated with higher bacterial counts at the teat orifice [26] and could be prevented by post-milking teat disinfection.

Research has made progress in revealing the significance of the way in which the milking machine influences new infection but until relatively recently there has been little research on the forces applied by the machine and their effect on the health of the teat and teat duct [27].

CONCLUSIONS

It would be absurd to attribute all the variations in the rate of occurrence of intramammary infection to changes in the levels of exposure to pathogens; there are many other factors. But it is unreasonable to regard the level of exposure to pathogens as by far the most important single factor in explaining the major variations in the occurrence of infectious mastitis in dairy herds. Much of the evidence for this is indirect but it is extensive and furthermore the techniques that are now used to obtain a good control of teat diseases are nearly always methods of reducing exposure to pathogens.

In all herds the routine methods of milking and cattle management result in the continuous spread of the common mastitis pathogens from cow to cow. By taking special precautions the spread can be reduced but not prevented. If teat skin is healthy and not colonised by pathogens the num-
ber of pathogens spread during milking may be relatively small even in herds not using teat disinfection and therefore bacterial penetration of the teat followed by intramammary infection will be an uncommon problem. Under these circumstances, providing the cows are housed under hygienic conditions and milked with an effective machine, mastitis is unlikely to be a problem. Unfortunately there are many factors which under normal commercial conditions greatly increase the exposure to pathogens. Some of these are microbial and others due to the methods of cattle management. When this occurs bacterial penetration of the teat duct is more frequent and mastitis becomes much more widespread. While the primary sites of pathogens (that is, udder infections, the intestinal tract) are important, the more significant sites in relation to herd mastitis problems are those where the pathogens subsequently multiply at or near the teat duct (that is, colonised skin, bedding). Of the many micro-organisms that can infect the mammary gland a small number cause most mastitis under commercial conditions. Their success may depend on their unique ability to multiply in sites at or near the teat duct. The most successful of all mastitis pathogens are those that multiply on damaged teat skin and therefore provide a continuous high exposure to the teat duct. This is presumably the reason why, prior to the introduction of disinfec tant teat dips S. aureus, Str. agalactiae and Str. dysgalactiae were by far the most important causes of infection.

The management methods commonly used in controlling bovine mastitis will have varying effects on the multiplication of mastitis pathogens in secondary sites. The principal ones that will have major effects are post-milking teat disinfection, practices that help to maintain healthy teat skin and avoid teat skin lesions of any type, housing methods that renew bedding materials frequently or avoid organic bedding materials and methods of preventing the multiplication of pathogens in water used for udder washing. All these can be expected to be particularly important in mastitis control. There are other management methods such as udder washing and milking machine cluster flushing which, on their own, will have little or no effect on multiplication of pathogens and therefore will be much less important in disease control. In this general respect the role of milking machines is complex but the main way in which they will influence exposure is likely to be their direct effect on the health of the teat duct and the skin of the teat.

Whilst these are general principles it must be recognised that visual inspection of herd conditions is not necessarily a good guide to levels of exposures. For herds not using teat disinfection there is considerable variation in the frequency of the colonisation of apparently healthy teat ducts and the reasons for this are not obvious and have not been investigated. Furthermore, cows can be bedded under conditions that keep them very clean and yet be exposed to enormous numbers of pathogens.

From these considerations it would appear that it is the multiplication of mastitis pathogens in secondary sites that is the principal factor in the aetiology of bovine mastitis economic importance. If this is so it provides a lead for further research to improve mastitis control and a guide to extension workers in examining herd mastitis problems caused by atypical pathogens.

References

EFFECT OF MILKING FREQUENCY ON YIELD, COMPOSITION AND PROCESSING QUALITY OF MILK

Labour shortage on farms and time spent at milking are major issues on many farms both in Ireland and other dairying countries. Reducing milking frequency from twice daily milking (TDM) to once daily milking (ODM) or milking thirteen times weekly (13TWM) may present a mechanism for reducing labour demand. A number of studies on ODM (mostly short-term, 1-4 weeks) have been conducted in New Zealand since the early 1990’s. ODM has been shown to induce a significant transitory increase in somatic cell count (SCC) (StiWagen and Lacy-Hubert, 1996; Holmes et al., 1992) even though there appeared to be no difference in the incidence of infection. ODM also results in changes in mammary permeability, leading to changes in milk composition (StiWagen and Lacy-Hubert, 1996; StiWagen et al., 1995). The objective of this study was to establish if ODM or omitting one milking weekly are feasible labour saving options in Irish herds, given expected changes in cow performance and milk quality.

The experiment was a randomized block design with three groups of cows each receiving one of three milking treatments. Seventy two cows were assigned to three treatments (ODM, 13TWM and twice daily milking [TDM]) from 4 October to 12 December. Cows were on average 218 days into lactation at the start of the trial. Cows were managed similarly throughout the trial. Milk yields and gross milk composition of cows on all treatments were measured, and milk samples for detailed compositional and processability analysis were collected from TDM and ODM treatments at two consecutive milkings and at one milking weekly, respectively. Milk yield was significantly reduced (p<0.001) and milk fat and protein concentrations were increased (p<0.01) with ODM compared to TDM. Milk yield and fat and protein concentrations of milks from TDM and 13TWM herds were similar. Casein concentrations in ODM and TDM milks were similar, but ODM milk had a higher (p<0.05) whey protein content. Somatic cell count of both milks was similar. Rennet coagulation time (RCT) and curd firmness (A60) of milks were not affected by milking frequency. Plasmin activity in ODM milks was higher than in TDM milks, but the effect was not significant. ODM milk had higher NAGase activity than TDM milk (p<0.01). In conclusion, once daily milking reduced milk yield by 29% and did not adversely affect the processability of milk. In addition, one evening milking per week could be eliminated without experiencing any adverse effects on milk yield or composition (O’Brien et al., 2002).

References

<table>
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<tr>
<th>Table 1: Yield and composition of milk in cows on three milking regimes (TDM, 13TWM, ODM)</th>
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<tbody>
<tr>
<td>TDM</td>
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<tr>
<td>---</td>
</tr>
<tr>
<td>Milk yield (kg/cow/day)</td>
</tr>
<tr>
<td>Fat content (%)</td>
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<tr>
<td>Protein content (%)</td>
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<tr>
<td>Lactose content (%)</td>
</tr>
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<table>
<thead>
<tr>
<th>Table 2: Processability characteristics of milk in cows on twice and once daily milking regimes</th>
</tr>
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<tbody>
<tr>
<td>Period</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>SCC (x 10^3 cells/ml)</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>Casein content (g/kg)</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>Whey protein (g/kg)</td>
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<tr>
<td>2</td>
</tr>
<tr>
<td>RCT (min)</td>
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<tr>
<td>2</td>
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<tr>
<td>A60 (mm)</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>Plasmin (AMC units/ml)</td>
</tr>
<tr>
<td>2</td>
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</tbody>
</table>

1 Period 1 = 4 October to 7 November; Period 2 = 8 November to 12 December
2 ns = non-significant

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IMPLICATIONS OF THE INTRODUCTION OF AUTOMATIC MILKING ON DAIRY FARMS: PROGRESS DURING THE FIRST 12 MONTHS

During the first twelve months of the European project, 'Implications of the introduction of automatic milking on dairy farms' experimental set-ups have been developed, discussed and partially started. The first results have been compiled in four reports. The atmosphere among the partners is good and farmers involved are in general positively minded about the project. This offers good opportunities for prosperous future activities.

In the Mastitis Newsletter No 24 in 2001 the set up of the project was elucidated. This article gives an up to date overview on the progress of the project.

Progress

The project started in December 2000. In January 2002 the first progress report was delivered to the EU describing all the work performed in the period from December 1, 2000 until November 30, 2001.
The work carried out so far is done in good consultation with all research and industrial partners. The atmosphere is pleasant and enthusiastic. Every six months a Project Management Committee (PMC) meeting is held at one of the participating research institutes, found in 6 different countries. At these meetings, besides organisational matters, the progress of the planned work is discussed with all partners.

Division of tasks

The project is divided into eleven work packages. These cover topics ranging from socio-economic aspects to operational management of the AM-system. Every work package is managed by one of the research partners. The partners are responsible for the scientific set up of the project and the execution of the fieldwork as well as the compilation of the results. Per work package this is organised in so-called 'dynamic work plans' (DWP). These DWPs are updated every six months and discussed with partners involved in the specific work package. The general outlines and results are also discussed at the PMC meetings.

In contradiction to earlier communication not four but all six currently operating suppliers of AM-systems are involved in the project. During the course of the project, their task is mainly to deliver the addresses of potential farmers involved, to contact the farmers, to make sure that the research is practically applicable and to think along with experimental set ups. Through the industrial partners, a letter was sent to all farmers with an automatic milking system in the countries involved, informing them about the project and that they may be approached for further research on their farm.

Work and first results

During the first twelve months, ten out of the total of eleven work packages started. Most work focussed on setting up experimental fieldwork, discussing experimental set-ups with partners involved and approaching the first farmers. Due to Foot and Mouth Disease (FMD) some fieldwork was delayed. However, it is still expected that all milestones set within the project can be met. Furthermore, two literature studies were performed, one inventory was executed and a protocol designed. This resulted in four deliverables:

- Work package no. 1 - Socio Economic Aspects of Automatic Milking - Literature review on the determinants and implications of technology adoption - Meskens, L., M. VanderMersch and E. Mathijis
- Work package no. 2 - Public Acceptance of Automatic Milking - Literature review on acceptability of and public opinion on automatic milking systems - Roe, K. and H. van den Bulck
- Work package no. 7 - Optimal Cleaning of Equipment for Automatic Milking - Investigation of systems, procedures and demands - Schuiling, E., J.A.M. Verstappen-Boerekamp, K. Knappstein and C. Benfalk

Dissemination

The project will yield 26 deliverables in the form of public reports. Besides this, dissemination in other ways will take place as much as possible. So far, several articles have been published in trade journals and two papers have been presented. Furthermore, at the First North American Conference on Robotic
Milkings to be held from March 20 until March 22, 2002 in Canada, severe poster and papers will be presented on topics studied within the project. See the congress site for more information: http://www.ontariodhi.com/robotics.

Besides publication, presentations for target audiences were given. These audiences vary from the dairy industry, technical consultants, cooling industry, milk control stations to, of course, farmers.

Web-site
(http://www.automaticmilking.nl)

In June 2001, the project was complemented by putting its web-site into the air. The web-site contains general project information, news flashes, work package descriptions, list with deliverables and a list with partner information. It is continuously updated with new information. All dissemination coming out of the project will also be placed on the site, including articles and reports. The first four research reports are available to download.

Symposium

In January 2002, a start will be made with the organisation of an extended symposium to be held in the spring of 2004 in The Netherlands. The first announcement will be presented at the end of March 2002 through the project’s web-site, at the First North American Conference on Robotic Milking and by personal mailing lists. At the EU symposium all pertinent results from the eleven work packages will be presented and every other person working on automatic milking is invited to present their knowledge.

Future actions

In the next twelve months nine more deliverables are expected. Furthermore, during this period many experiments will continue or start and available results will be disseminated to target groups. In month 24 a workshop will be held on the overall progress. Finally, on a regular basis, articles on the progress of the project will be published in future Mastitis Newsletters.

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Industrial and Research partners of the EU project ‘Automatic Milking’

DEFINITION OF THE PHYSIOLOGICAL CELL COUNT THRESHOLD BASED ON CHANGES IN MILK COMPOSITION

Only healthy cows with four healthy udder quarters can guarantee an optimised use of the genetically determined yield potential and provide milk that may be employed without restrictions for further processing and refinement to dairy products, and meets the consumer’s demand for high quality milk as a natural, healthy and wholesome basic nutrient. Therefore, maintaining the bovine mammary gland healthy should be a concern to dairy farmers, the dairy industry and the consumers.

According to the available knowledge, it must be assumed that only milk of healthy mammary glands present a normal, "physiological" composition [1,2,3]. An udder quarter is defined as healthy when somatic cell count is < 100 000 cells/ml and no mastitis pathogens were found [4, 5, 6]. The minimum requirements established by the legislation for milk of highest quality are based however on thresholds employed to minimise a possible public health risk for the milk consumer. These thresholds have no relation to the definition of udder health categorisation resulting thus in a discrepancy between milk payment according to "quality" on one hand and the udder health resp. the expectation of the consumers on the other hand.

While at present, a threshold of 100 000 cells/ml milk can be assumed as an internationally accepted definition of udder health, the cytological thresholds for categorising the quality of bulk milk vary internationally between 250 000 to 750 000 cells/ml [7].

Thus the question arises whether interactions between cell count and milk constituents exist and whether these may lead to significant alterations of milk composition considering a threshold of 100 000 cells/ml. It should be emphasised that udder health is diagnosed on the base of cyto-bacteriological examinations of quarter foremilk samples while for the evaluation of milk quality, cell count is determined in bulk milk samples.

The cytological level of quarter foremilk samples (QFM) from healthy udder quarters is significantly lower than corresponding values of quarter composite milk samples (QCM) yet comparable with the latter within the range of < 100 000/ml [8]. This means that, having four healthy udder quarters, the somatic cell count of the corresponding cow composite milk sample will not exceed 100 000 cells/ml. Previous publications confirm this observation [8, 9, 10].
PRESENT STUDY

Material
Two commercial herds with a total of 150 high-yielding German Holstein cows and a annual lactation yield of x = 8500 kg/cow were sampled over a period of 1.5 years with weekly intervals during the first eight weeks of lactation and last three weeks previous to dry-off, and monthly intervals for the time in between. After dry cleaning and disinfection of teat tips with 70% ethylene alcohol had taken place, QFM samples were drawn. Milking was done by a quarter milking machine in order to collect a composite milk sample of every quarter (QCM) after milking had finished.

Methods
Quarter foremilk samples were used for cyto-bacteriological examination and for measuring NAGase activity and electrical conductivity. Counting of somatic cells was done by Fossomatic (precision: Cv < 5%), and bacteriological examination was performed according to National Mastitis Council recommendations [11]. In QCM samples, somatic cell count was determined along with NAGase, lactate, lactose, chloride, potassium and electrical conductivity. The methods of milk components’ determination were published previously [12].

Results
Figure 1 compares the frequency of distribution of QFM and QCM samples in relation to cell count level.

Cell counts < 50 000/ml milk were observed for 60% of the QFM and 48% of the QCM samples. Geometric means of cell counts amounted to 4.61 ± 0.67 (QFM) and 4.80 ± 0.63 (QCM) with a significant difference (p < 0.01).

Table 1: Mean NAGase and electrical conductivity in quarter foremilk samples (n = 10854) in relation to cell count classes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>0 - 50</th>
<th>&gt; 50 - 100</th>
<th>&gt; 100 - 200</th>
<th>&gt; 200 - 400</th>
<th>&gt; 400</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAGase [U/10^6/ml]</td>
<td>0.20 ± 0.23</td>
<td>0.38 ± 0.24</td>
<td>0.48 ± 0.26</td>
<td>0.64 ± 0.29</td>
<td>0.87 ± 0.34</td>
</tr>
<tr>
<td>EC [mS/cm]</td>
<td>5.45 ± 0.48</td>
<td>5.86 ± 0.66</td>
<td>6.06 ± 0.83</td>
<td>6.38 ± 0.99</td>
<td>6.69 ± 1.15</td>
</tr>
</tbody>
</table>

*= electrical conductivity

![Figure 2: Means of milk constituents in quarter composite samples (n = 9326) in relation to cell count classes](image)

![Figure 3: Means of milk constituents in quarter composite samples (n = 9326) in relation to cell count classes](image)

![Figure 1: Distribution frequency of cell counts (approximated to density function)](image)

Table 1 (QFM) and Figures 2 and 3 (QCM) present the means of milk constituents in relation to the cell count classes.

All means of the milk constituents in Table 1 and Figures 2 and 3 differ significantly (t-test; p < 0.001) in relation to cell count classes.

In order to improve the comparability of the relation between cell count level and milk constituent concentration in QCM samples, all means were transformed to log at base 10, and these means were compared with the overall mean of all samples (Figure 4). To achieve this, the overall mean was subtracted from every cell class mean. Thus, the straight line (overall mean) was taken for reference for all parameters in accordance to cell count classes.
Figure 4: Mean deviation (in log10) of selected milk constituents from the overall means in relation to cell count classes (n = 9326 QCM samples)

Figure 4 represents the deviations of milk constituent concentrations from the corresponding overall mean in every cell count class.

A clear modification of gradient and direction in the curves of all milk constituents occur in the cell count range > 100 000 cells/ml. Evidently, this turning point indicates a cell count range that corresponds with the process of leaving the physiological norm. The significant differences between the means of the parameters in relation to the cell count class (Figures 2 & 3) also demonstrate a massive change in the values beyond the cell count class 50 – 100 000 cells/ml, and reinforce the statement given at this point.

DISCUSSION

Milk composition is influenced by a variety of factors as it can be seen from Figure 5.

Mastitis may be characterised by the changes in concentration of numerous milk constituents [13]. Since more than thirty years however, cell count has been established as the main diagnostic criterion due to its high potential of differentiation and its cost-effectiveness in measuring [1, 3, 6, 14]. The amount of somatic cells describes the integrity of the blood-milk barrier, as many papers prove that the physiological range of up to 100 000 cells is not exceeded in the mammary gland when no pathogens are encountered throughout the entire lactation [8, 9, 15]. In this way, Doggweiler & Hess [15] calculated a mean cell count of 22 000 cells/ml for 3770 healthy udder quarters that, adding the double standard deviation as common practice in medical sciences to ensure reliability, lead to the threshold of 100 000 cells/ml for “normal secretion”. The related cell count distribution curve is presented in Figure 6.

With the exception of traumatic causes, micro-organisms are always involved in mastitis development. Thus, the conclusion may be drawn that the milk composition from mammary glands free from an infection and with a cell count < 100 000 cells/ml should be defined as physiological.

Although changes in the concentration of some milk components (Figure 4) do occur already between 10 000 and 100 000 cells/ml, these can be accounted for variations within the physiological range.

As early as 1971, Tolle et al. [1] published a study about the relation between cell count and milk constituents (sodium, potassium, chloride, whey nitrogen, lactose) that found out that these substances leave the physiological range when cell count increases to > 100 000 cells/ml. Figure 7 summarises these results.

Although the amount of somatic cells was measured by a Coulter Counter in that study, the data in Figures 2, 3 & 4 confirm the paper’s basic statement that milk constituents abandon their physiological ranges beyond a cell count of 100 000 cells/ml.

Other papers show comparable results and confirm significant changes in milk composition once the cell count exceeds the threshold of 100 000 cells in milk [3, 12, 16, 17].

These changes in milk composition with cell counts > 100 000 cells/ml also lead to important impairments of the technological processability and refinability of milk.

Figure 6: Distribution of milk somatic cells of healthy heifers - 3770 udder quarters from different breeds - (Adapted from DOGGWEILER & HESS, 1983)
Numerous studies suggest corresponding effects on renneting behaviour of milk, cheese yield, sensorial and keeping quality, even in pasteurised milk [2, 10, 18, 19]. Furthermore it must be emphasised that unphysiologically high cell counts lead to significant milk yield reductions [1, 20, 21].

CONCLUSION

For the physiologically normal secretion of bovine mammary glands, a scientifically-based somatic cell count range of up to 100 000 cells/ml should be considered as a ‘golden standard’. Having analysed six milk constituents in 9326 quarter composite samples in relation to different cell count classes, results of the present study including information from the literature indicate clearly that the concentrations of milk constituents vary significantly (p < 0.001) from the physiological norm once the threshold of 100 000 cells/ml is exceeded, and must therefore be defined as abnormal. With other words, physiological normal milk can be defined as milk with a cell count of less than 100 000 somatic cells/ml milk.

Considering technological impairments and milk yield reductions linked to unphysiological cell counts in milk, the goal of keeping the bovine mammary gland healthy has to be pursued more intensively.

However, the question whether scientifically-based standards like the cell count and, consecutively, milk composition will have any major influence on the milk payment according to quality, remains unanswered. Regarding general economical conditions of each nation, economical interests of the dairy industry and the consumers’ pluriconditioned demands for high quality milk and milk products, cell count thresholds for milk will be defined differently.

REFERENCES

RELATIONSHIP BETWEEN SOMATIC CELL COUNT AND NEUTROPHILS IN MILK

Polymorphonuclear leukocytes (PMN) constitute one of the main somatic cell types in milk and their number increases with mastitis infection (Burvenich et al., 1995). The measurement of PMN level may provide a more accurate indicator than somatic cell count (SCC) of infected quarters at drying off, thereby allowing antibiotic therapy to be limited to those quarters and may also be useful in selecting milk for processing (O'Brien et al., 1999). The objective of the present study was to establish the relationship between SCC and PMN levels in quarter, bulk cow and bulk herd milks. The correlation (r²) between the microscopic count and the PMN assay was 0.97 (n=13). Milk samples from 332 cow quarters, 464 bulk cows (at the am milking) and 548 bulk herds were collected from cows in mid-lactation. A subsample (10 ml) was taken from each and stored at -30°C until tested for PMN. The fresh sample was tested for SCC using a Bentley Somacount 300. The r² values between SCC and PMN levels in milks with SCC <400 x 10⁶/ml from quarter (n=326), cow (n=421) and herd (n=464) were 0.84, 0.75 and 0.63, respectively. The best correlation between SCC and PMN was shown in milks from individual udder quarters. The poorer correlation obtained in cow and herd bulk milks was probably due to dilution. At SCC levels between 1 x 10⁶ and 100 x 10⁶/ml and between 300 x 10⁶ and 400 x 10⁶/ml in quarter milks, PMN constituted 5 and 56% of the total somatic cells, respectively. Two arbitrary levels of PMN were set at less than 20% and greater than 70% to indicate low and high PMN levels.

At SCC levels between 1 x 10⁶ and 100 x 10⁶/ml in quarter milks, PMN constituted <20% and >70% of the total somatic cells in 93 and 2% of the milks, respectively (Table 1). At SCC levels between 300 x 10⁶ and 400 x 10⁶/ml, PMN constituted <20% and >70% of the total somatic cells in 0 and 40% of the milks, respectively. PMN levels ranged from 0 x 10⁶ to 50 x 10⁶/ml in quarter milks of SCC 80 x 10⁶ to 100 x 10⁶/ml (Figure 1). It is concluded that PMN may be useful in selecting udder quarters for antibiotic treatment at drying-off and may also provide a more reliable method for future selection of milk for processing.

References

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Table 1: % of SCC values (in various SCC categories) with <20% PMN and >70% PMN

<table>
<thead>
<tr>
<th>SCC category (x 10⁶ cells/ml)</th>
<th>Quarter milk &lt;20</th>
<th>Quarter milk &gt;70</th>
<th>Cow milk &lt;20</th>
<th>Cow milk &gt;70</th>
<th>Herd milk &lt;20</th>
<th>Herd milk &gt;70</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-100</td>
<td>93</td>
<td>2</td>
<td>79</td>
<td>7</td>
<td>32</td>
<td>18</td>
</tr>
<tr>
<td>100-200</td>
<td>26</td>
<td>16</td>
<td>36</td>
<td>19</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>200-300</td>
<td>0</td>
<td>33</td>
<td>29</td>
<td>24</td>
<td>7</td>
<td>32</td>
</tr>
<tr>
<td>300-400</td>
<td>0</td>
<td>40</td>
<td>17</td>
<td>25</td>
<td>10</td>
<td>31</td>
</tr>
</tbody>
</table>

Figure 1: Typical variation in PMN in quarter milks (n = 11) with SCC between 80-100 x 10⁶ cells/ml
EFFECTS OF BOVINE ANTIBODIES DIRECTED AGAINST FERRIC CITRATE RECEPTOR OF ESCHERICHIA COLI, FECA, ON BACTERIAL IRON ACQUISITION, BACTERIAL GROWTH, AND SEVERITY OF EXPERIMENTALLY INDUCED BOVINE MASTITIS

(Summary of a recent PhD Dissertation)

Bovine mastitis remains the most costly disease in animal agriculture. Because coliform bacteria are ubiquitous in the environment of dairy cows and that teat ends are continuously exposed to them, increased resistance of cows to pathogens seems to be a reliable approach to control coliform mastitis. Some success has been made based on immunization with Escherichia coli JS strain that is a mutant strain exposing lipopolysaccharide core structure. Escherichia coli JS immunization reduced the incidence and the severity of clinical coliform mastitis, however failed to prevent new intramammary infection (IMI) caused by coliform bacteria. Therefore, new vaccines that prevent new coliform IMI could be beneficial.

Iron is crucial to maintain normal cellular metabolism for almost all bacteria. In bovine mammary secretions, extracellular iron is mainly bound to lactoferrin during the non-lactating period and to citrate during the lactating period. Those host ligands keep the concentration of free iron well below the levels required to support bacterial growth, therefore coliform bacteria need specific mechanisms to acquire iron in mammary glands. Under iron-restricted conditions, coliform bacteria utilize multiple iron transport systems to acquire iron. The ferric citrate transport system is one such system of E. coli, and can be induced when more than 0.1 mM citrate exists in the microbial environment. The system involves the outer membrane receptor, FecA, to bind to and internalize ferric citrate complex. Mammary gland is iron-restricted and bovine milk contains approximately 7 mM citrate that is sufficient to induce the ferric citrate transport system. The hypothesis of this study was that E. coli utilize FecA and the ferric citrate transport system to acquire iron in the lactating mammary gland. The hypothesis was based on the finding that coliform isolates from cases of naturally occurring mastitis expressed FecA when bacteria were cultured in concentrations of citrate comparable to that in the lactating bovine mammary gland.

Bacterial outer membrane receptors have been vaccine candidates, because they are surface exposed, are immunogenic, and may induce protective immunity against bacterial infections. Previously, FecA has shown to be immunogenic in rabbits. This study investigated effects of FecA immunization in cows focusing on: 1) humoral immune responses following the FecA immunization, 2) effects of antibodies from FecA immunized cows on bacterial iron acquisition and growth, and 3) the severity of experimentally induced E. coli mastitis.

Twenty-one cows were assigned to one of three treatments: 1) FecA immunization, 2) E. coli JS immunization, and 3) unimmunized controls. Immunizations were: 1) subcutaneous injection at 14 days prior to drying off, 2) intramammary infusion at 7 days after drying off, and 3) subcutaneous injection at 28 days after drying off. FecA was derived from E. coli UT5600/pSV66 (Lin et al. 1999). The FecA vaccine consisted of 400 mg in 5 ml of PBS and was emulsified in 5 ml of Freund's incomplete adjuvant. Escherichia coli JS vaccine consisted of 10⁶ killed E. coli JS cells/ml and water soluble adjuvant. Intramammary challenge was by infusion of approximately 60 colony-forming units of E. coli 727 into one uninfected mammary gland approximately 3 weeks after parturition. Quarter foremilk samples from the challenged quarter were taken immediately prior to challenge, 3, 6, 9, 12, 15, 18, and 21 hours after challenge, and also 1, 2, 3, 4, and 7 days after challenge. Blood samples were taken 14 days before drying off, 28 days after drying off, within 24 hours after calving, immediately prior to challenge, and 7 days after challenge.

Bacterial numbers and somatic cell counts (SCC) were measured in foremilk samples from the challenged quarters. The clinical severity of induced mastitis and the rectal temperature of the experimental cows were recorded immediately prior to the challenge and each time quarter foremilk samples were taken postchallenge. Antibody titers for immunoglobulin (Ig) G, IgG₂, and IgM in serum and whey were determined by ELISA. The coating antigens were purified FecA, E. coli 727 grown in an iron-replete medium, and E. coli 727 grown in an iron-depleted medium containing 1 mM citrate.

Although cows immunized with FecA had increased antibody titers against FecA in serum and whey compared with other treatment groups, the immunization with FecA had minimal effect on bacterial num-
bers, SCC, and clinical severity of experimentally induced *E. coli* mastitis. However, increased antibody titers against FecA in serum were associated with reduced peak bacterial numbers in milk from the challenged mammary glands. Because FecA is a bacterial receptor to acquire iron that is an essential nutrient for bacterial growth, we performed the iron transport assay to investigate effects of antibodies from FecA immunized cows on iron acquisition of *E. coli*.

Immunoglobulin G was purified from colostral whey by Protein G affinity chromatography for each treatment group. Fifteen field isolates of *E. coli* and *E. coli* UT5600/pSV66 were grown in an iron-depleted medium containing 1 mM citrate to induce FecA. *Escherichia coli* were incubated with $^{55}$Fe at 37°C in the presence of purified IgG (0, 2, and 4 mg/ml) from FecA immunized cows and unimmunized control cows. After 5, 10, and 15 minutes of incubation, the radioactivity of $^{55}$Fe taken up by *E. coli* was measured by a liquid scintillation counter. The iron transport assay was repeated three times for each *E. coli* field isolate and for *E. coli* UT5600/pSV66 using the partially balanced incomplete block design.

Titers for 4 mg/ml purified IgG against FecA were 1:5120 for FecA immunized cows (anti-FecA IgG), 1:1024 for *E. coli* J5 immunized cows (anti-J5 IgG), and 1:64 for unimmunized control cows (control IgG). Expression of FecA was confirmed for all *E. coli* isolates used for the assay by SDS-PAGE of the outer membrane proteins followed by immunoblotting with anti-FecA IgG (0.4 mg/ml). The presence of anti-FecA IgG reduced $^{55}$Fe uptake by *E. coli* field isolates compared with control IgG. Anti-FecA IgG also reduced $^{55}$Fe uptake by *E. coli* UT5600/pSV66 and the reduction was greater than that observed with the field isolates. Because anti-FecA IgG decreased bacterial iron uptake, we next investigated effects of anti-FecA IgG on the in vitro growth of *E. coli*.

Fourteen field isolates of *E. coli* and *E. coli* UT5600/pSV66 were cultured at 37°C in an iron-depleted medium containing 1 mM citrate and purified IgG (0, 2, and 4 mg/ml) from FecA immunized cows, *E. coli* J5 immunized cows, and unimmunized control cows. Bacterial numbers were determined at 0, 6, 12, and 24 hour incubation. To investigate the effect of exogenous iron, 50 μM FeCl$_3$ were added to the assay. The assay was in duplicate for *E. coli* field isolates and repeated 6 times for *E. coli* UT5600/pSV66.

Iron restriction decreased growth of *E. coli*, and the presence of IgG further decreased the growth over iron restriction alone. For *E. coli* field isolates, the growth did not differ among IgG sources nor between concentrations of IgG. However, for *E. coli* UT5600/pSV66, the growth was significantly decreased in the presence of anti-FecA IgG after 6 hour and 12 hour incubation, in the presence of anti-J5 IgG after 6 hour incubation, and in the presence of control IgG after 6 hour, 12 hour, and 24 hour incubation compared with the growth in an iron-depleted medium. Exogenous iron increased the growth of *E. coli* in the presence of anti-FecA IgG and anti-J5 IgG, but not control IgG, suggesting specific growth inhibitory effects in IgG from FecA and *E. coli* J5 immunized cows.

*Escherichia coli* utilize multiple iron transport systems under iron-restricted conditions. The FepA and enterobactin based system is another iron transport system utilized by coliform bacteria from cases of naturally occurring mastitis under iron-restricted conditions, and is the most likely system utilized in bovine mammary glands when the ferric citrate transport system is not available. The immunization with FecA in cows generated antibodies directed against FecA, these antibodies decreased bacterial iron uptake and reduced the growth of *E. coli* in vitro. However, the effect of FecA immunization on the clinical severity of experimentally induced *E. coli* mastitis was minimal. *Escherichia coli* might have used the FepA and enterobactin based system to acquire iron in mammary glands instead of functionally compromised FecA for the ferric citrate transport system due to antibodies directed against FecA.

To eliminate the iron uptake through the FepA and enterobactin based system, *E. coli* strain UT5600/pSV66 was tested. The strain lacks fepA gene and does not express FepA, and the ferric citrate transport system is the sole known system to acquire iron under the given conditions in the iron transport assay and the in vitro growth assay. In the presence of anti-FecA IgG, the reduction in bacterial iron uptake and growth were greater for *E. coli* UT5600/pSV66 than for *E. coli* field isolates. However, anti-FecA IgG did not prohibit the iron uptake and the growth of *E. coli* UT5600/pSV66. In this study, cows were immunized with whole FecA protein. Functional epitopes of FecA to transport ferric citrate complex maybe locate within certain residues of surface exposed loops of the whole FecA protein as suggested for FepA. Even though antibody titers against whole FecA increased in FecA immunized cows, the amount of antibody actually directed against the ligand-binding sites of FecA might have been insufficient to prohibit the iron uptake and the growth of *E. coli*.

Although bovine milk contains over the threshold concentration of citrate required to induce FecA, in iron-restricted mammary glands, *E. coli* may utilize both the FepA and enterobactin based system and the ferric citrate transport system to acquire iron during the lactating period. In the present study, immunization with FecA did result in the production of antibodies that reduced iron uptake and growth of *E. coli* in vitro. This finding has importance as the lactating bovine mammary gland contains a very high concentration of citrate that coliform bacteria could utilize to acquire iron. Iron is one of the essential but limited nutrients for bacteria to establish infections. Further research is needed to determine which bacterial iron transport systems coliform bacteria utilize to infect the lactating bovine mammary gland. Clearly, the ability to block iron uptake of coliform bacteria by immunization would result in improved control of coliform mastitis in dairy herds.

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CONTAGIOUS AND ENVIRONMENTAL PATHOGENS: FROM DICHOTOMY TO SLIDING SCALE

"Contagious mastitis" and "environmental mastitis" are labels used to classify the epidemiology of pathogens that cause intramammary infections in dairy cows. The primary reservoir of contagious pathogens consists of infected udders, while the primary reservoir of environmental pathogens is the dairy cow's environment. Contagious mastitis is transmitted from cow to cow during milking, whereas exposure to environmental pathogens can occur at any time during an animal's lactating or non-lactating life. *Staphylococcus aureus* is categorized as a contagious pathogen and *Streptococcus uberis* is categorized as an environmental pathogen (Fox and Gay, 1993; Leigh, 1999; Smith and Hogan, 1993). This dichotomous paradigm is contradicted by studies on dairy herds in the Netherlands, where *S. aureus* and *S. uberis* are among the predominant causes of subclinical and clinical mastitis in dairy herds.

Dynamics of mastitis at herd level

The dynamics of *S. aureus* and *S. uberis* mastitis were observed in a longitudinal prospective study of three commercial dairy herds in the Netherlands. Herds were selected based on a history of at least a year of medium level bulk milk somatic cell count (BMSCC; 200,000 - 300,000 cells/ml) despite implementation of most if not all points of the standard mastitis prevention program (Zadoks et al., 2001a). *Staphylococcus aureus* and streptococci had been the main cause of infection in each herd. For 18 months, quarter milk samples were collected at 3-week intervals from all lactating animals. Additional samples were collected at calving or purchase (entry into the milking herd), dry-off or culling (exit from the milking herd), and when clinical mastitis was observed. All milk samples were used for bacteriologic culture according to National Mastitis Council standards (Harmon et al., 1990). Infection status of quarters was defined using the number of bacterial species and colony forming units that were present in multiple consecutive samples (Zadoks et al., 2001b). To determine whether *S. aureus* and *S. uberis* behaved as contagious or environmental pathogens in the study herds, two approaches were used: mathematical modeling and molecular typing.

**Mathematical modeling of mastitis**

Diseases that are transmitted through individual-to-individual contact, such as contagious mastitis, can be described in mathematical terms by a Reed-Frost model. This model assumes that the probability of infection for a susceptible individual depends on the number of infectious individuals to which it is exposed. For other disease agents, for example, for environmental pathogens, the probability of infection depends on the balance between susceptibility of the individual and infection pressure in the environment. The number of infected herd mates does not enter in the equation. Such models are known as Greenwood models. Comparison of field observations on the number of new mastitis cases with predictions from mathematical models can be used to determine which model, and hence which mode of transmission, best describes the population dynamics of mastitis (De Jong, 1995; Zadoks et al., 2001b).

**Molecular epidemiology of mastitis**

Bacteria are classified by genus and species. Within bacterial species, further classification into bacterial strains is possible. Classification of strains, or subtyping, is done by means of phenotypic and genotypic techniques. Phenotypic techniques, such as antibiotic susceptibility testing, serotyping and phage typing, depend on the expression of phenotypic characteristics. Genotypic techniques or molecular typing methods, such as ribotyping, pulsed-field gel electrophoresis or PCR-based typing methods, detect variability in genetic material of bacteria. When spread of mastitis in a dairy herd is the result of contagious transmission, the majority of animals will be infected with the same bacterial strain. When infections originate in the environment, each cow can become infected with a different strain. Comparison of strains isolated from different cows within a herd allows for identification of non-contagious transmission.

![Figure 1: Number of quarters that was infected with a specified strain of Streptococcus uberis during an 18-month observation period with 27 farm visits at 3-week intervals in a dairy herd with 95 ± 5 lactating animals. Strains were specified for 39 out of 54 observed infected episodes by means of RAPD fingerprinting.](image-url)
Streptococcus uberis behaves as contagious pathogen

In one study herd, an outbreak of S. uberis mastitis occurred. Mathematical modeling revealed that the number of existing infections was a significant predictor for the number of new infections. This suggests contagious transmission. Strain typing of S. uberis isolates by means of random amplified polymorphic DNA (RAPD) fingerprinting supported that idea: the vast majority of isolates in the herd belong to one strain (Figure 1). Infections with the predominant strain were only observed in lactating cows, never in dry cows, while infections with other strains were observed in dry cows and heifers. The combined information points towards contagious transmission of S. uberis via the milking machine. And indeed, S. uberis was isolated from milking equipment. Even when one or two non-infected cows were milked after an S. uberis infected cow, the S. uberis strain from the infected quarter could still be isolated from teat cup liners.

The emphasis on the environmental nature of S. uberis mastitis, as dictated by the current paradigm, is a result of the failure to eradicate S. uberis mastitis through measures aimed at control of contagious mastitis, i.e. the standard mastitis prevention program (Bramley, 1984). In fact, implementation of the standard mastitis prevention program leads to a significant decrease in incidence and prevalence of S. uberis mastitis (Neave et al., 1969; Robinson et al., 1985). When measures from the 5-point plan are omitted, outbreaks of mastitis may occur (Catell, 1996; Zadoks et al., 2001). Several strain typing studies suggested that contagious transmission of S. uberis at milking time may occur (Bassogio et al., 1997; Hill, 1988; Phuektes et al., 2001), and our study has shown that the milking machine may well act as a focus in spread of S. uberis.

Staphylococcus aureus behaves as environmental pathogen

For transmission of S. aureus, the number of existing infections in the study herds was not significant as a predictor for the number of new infections, suggesting that there was no or only limited contagious transmission. The "contagiousness" of a pathogen can be quantified by the reproductive number, R. R is the number of new infections produced by a primary infection before that primary infection disappears. When R is less than one, contagious transmission alone can not maintain a disease in a population. For each herd in our study, R was calculated to be less than one. This means that contagious transmission of S. aureus mastitis was indeed controlled. Even so, new infections continued to occur. New S. aureus infections, despite excellent mastitis control have been observed in other herds, too (Schukken et al., 1991; Hillerton et al., 2002). If infected herd mates are not the source of infection, then what is? Most likely: the environment. The dairy cow's environment harbours S. aureus in many places, and environmental S. aureus could well be the cause of infections in heifers or dry cows that are not exposed to the milking machine (Roberson et al., 1998).

Again, results from mathematical models and field observations are corroborated by strain typing data. The majority of isolates in any given herd usually belong to one subtype. At the same time, a multitude of S. aureus strains is isolated from dairy cows in most herds (Matthews et al., 1994). Heterogeneity of strains in combination with a low frequency of isolation within herds could be explained by an environmental origin of the rare strains. In our study, S. aureus isolates from heifers at calving belonged to a different strain than isolates from lactating cows in one herd, which proves that the lactating herd had not been the source of infection for the heifers. In another herd, new infections occurred at a time when no other infected animals were present in the milking herd as determined by the 3-weekly routine samplings. Though not conclusive, this observation suggests that the environment rather than herd mates had been the source of infection. As for the heifers, the strains isolated from the putative environmental infections were different from the strains originally present in the lactating herd (Zadoks et al., 2000).

Redefining the paradigm

In conclusion, arguments that are used to claim contagious transmission for S. aureus also apply to S. uberis, and arguments that are used to claim the environmental origin of S. uberis also apply to S. aureus. To which extent the arguments pertain, differs between the species. The epidemiology of mastitis pathogens is better represented by a sliding scale where the balance of contagious and environmental transmission shifts gradually, than by a species-based dichotomy (Figure 2). In addition, different strains within a pathogen species may differ in their speed and mode of spread, as indicated by recent studies on S. aureus (Middleton et al., 2001) and S. uberis (Zadoks, 2002). Thus, the concepts of "contagious" and "environmental" mastitis need to be interpreted at the level of the pathogen strain, rather than at the level of the pathogen species. Classification of all S. aureus as contagious and all S. uberis as environmental is an oversimplification of mastitis epidemiology, and may cause unnecessary loss and frustration in dairy herds.

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Figure 2: Sliding scale from contagious to environmental epidemiology of mastitis pathogens. SAG = Streptococcus agalactiae: contagious, eradication possible (Keefe, 1997; Loefller et al., 1995). SAU = Staphylococcus aureus: predominantly contagious, but partly environmental (our study; Roberson et al. 1994). SDY = Streptococcus dysgalactiae: intermediate between contagious and environmental (Bramley, 1984). SUB = Streptococcus uberis: predominantly environmental, but partly contagious (our study; Robinson et al., 1985). ECO = Escherichia coli: environmental, eradication impossible (Smith and Hogan, 1993).
INTERNATIONAL CONFERENCE ON THE 'BIOLOGY OF THE MAMMARY GLAND'

16th – 18th September 1999
Tours, France

The international conference on the 'Biology of the Mammary Gland' was organised from 16 to 18 September 1999 in Tours (France) by Charles Coutet (France) as a part of the European Union COST 825 Action. The conference was attended by more than 175 delegates from 20 different countries. Forty-eight oral presentations were performed in 8 separate sessions and more than 60 posters were presented.

Cell-cell interactions in mammary cancer was the subject of the first session with Paul Edwards (UK) as chairman.

In the second session, the immunology of the mammary gland was discussed. The session was chaired by Christian Burvenich (Belgium) and Evelyne Meyer (Belgium). A review of the mammary gland immunity around parturition was presented by K. Persson-Waller (Sweden). The role of the cells and cytokines in the inflammatory secretions of the bovine mammary gland was highlighted by C. Rollet (France). She emphasised the fact that macrophages are not only important in early non-specific defences, but these cells do also play a key role in specific immunity as antigen processing and presenting cells for the T-lymphocytes. A better understanding of these mechanisms could lead to the development of new vaccines and the use of cytokines in the immunomodulation of bovine mastitis. Max Paape (USA) stated that resident and newly migrating macrophages help to reduce the damage to the epithelium by phagocytosing PMN through a process called apoptosis. The immunology of the porcine mammary gland and the protection of neonate piglets was the topic of H. Salmon (France). The relationship between the feed tissue immune defences, especially changes in teat tickness, and intramammary infection risks were emphasized by G. Giovannini (Italy). Some results about the immunological aspects of pregnancy-associated glycoproteins in the bovine were presented by H. Dosogne (Belgium). Plasma levels of bPAG are quite high around parturition until 2 weeks after calving. The co-occurrence of the peak levels of bPAG with the impairment of PMN oxidative burst activity in early post-partum period might support the hypothesis of an immunosuppressive role of this hormone family. Finally, the session was closed by J. Leigh (UK) with a review of the current status and future prospects in vaccination against bovine mastitis due to Streptococcus uberis.

The third and last session of the first conference day dealt with mammary gland development. Especially the effect of lactogenic hormones, growth factors and transcription factors on the development of the mammary gland were discussed with D. Schams (Germany) as chairman.

Friday the 17th September started with the fourth session on signal transduction in mammary cancer. The main item in this session was human breast cancer.

The cellular mechanisms in mammary signalling pathways were the subject of the afternoon session with R. Clegg (Scotland) as chairman.

The sixth session (late afternoon) had the manipulation of milk composition as main item. The nutritional manipulation of milk proteins was tackled by H. Ruiquín (France). Three main points were stressed as being critical in milk protein synthesis: 1/ the supply of essential amino acids in a correct ratio, 2/ molecular determinism of protein synthesis and 3/ intracellular milk protein transport. The regulation and nutritional manipulation of milk fat was emphasised by D. Bauman (USA). The influences of milking interval and subclinical mastitis on single quarter milk composition during milking at different stages of lactation were presented by J. Blüm (Switzerland). The effect of feeding pattern and behaviour on hormonal changes and milk composition was stressed by G. Bertonoli (Italy). The plasminogen activator and its role on lactation and involution of the mammary gland was discussed by I. Politis (Greece). Possibilities to change milk fat composition by genetic modification were highlighted by J. Medrano (USA). The impact of genetic polymorphisms in milk protein genes on the milk composition is an important item in the dairy products industry, especially in cheese making ability of milks containing different lactoprotein variants. This problem was emphasized by P. Novka (Slovenia).

The last conference day, the 18th of september, started with the seventh session on transcription factors and gene expression in the mammary gland.

The conference was closed with the eighth and final session on steroid receptors, chromatin and co-activators.

In conclusion, it can be said that the conference was very successful due to the variety of items discussed and the large number of posters presented. Moreover, the interdisciplinary approach was well appreciated.

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IDF-SYMPOSIUM ON 'IMMUNOLOGY OF THE MAMMARY GLAND'
12th – 14th June 2000 Stresa, Italy

The borders of the 'Lago Maggiore' were a beautiful location for the IDF-symposium. A total of 5 different sessions were scheduled on the immunology of the mammary gland with each session consisting of lectures by 2 invited speakers on a specific topic, followed by 5 other researchers presenting their results and a poster session.

In the first session on Monday 12th June about 'cow factors', C. Burvenich (Belgium) presented the first lecture on physiological factors that influence the cows' resistance to mastitis, especially during early lactation. Genetic factors related to mastitis resistance were focused in J. Detilleux's (Belgium) presentation. M. Kehrl (USA) discussed the acute phase response of the bovine mammary gland to Escherichia coli. The other speakers in the first sessions presented lectures on inflammatory responses, neutrophil cell function, leukocyte populations, milk sampling procedures and genetics. The poster presentations had very diverse subjects, from E. coli and endotoxin mastitis, over leukocyte cell functions to mammary gland tissue sampling and cell culture models.

In session two on Monday afternoon, 'physical factors affecting immunity' were the main subject. The teat tissue resistance mechanisms with special regard to machine milking was the subject of J. Hamann's (Germany) presentation. This was followed by a presentation of K. Persson-Waller (Sweden) about stress factors influencing mammary gland immunity. She emphasized 4 different types of stress factors affecting the mammary gland immunity: physiological, pathological, physical and psychological factors. The subject of the following oral presentations were suckling-machine milking, keratin removal during milking, teat end changes and lesions, heat stress and regrouping and relocation of animals and the relation to their production performance. In the poster presentations, a variety of subjects was discussed: machine milking and teat injuries, several endocrine and immune responses, low SCC, teat sealants, receptor expression and clinical mastitis.

'Soluble factors affecting immunity' was the subject of the 3rd session on Tuesday 13th June with an opening lecture by K. L. Smith (USA) on nutritional factors affecting immunity and resistance to mastitis in dairy cows. This presentation was focused on the role of vitamin E and Selenium in mammary gland immunity and neutrophil cell function. The recruitment of neutrophils in the mammary gland, where a better understanding of the molecular and cellular mechanisms underlying this recruitment could lead to applications in vaccination, inflammatory modulation and selection of resistant animals was discussed by P. Rainard (France). Other lectures on the adherence of Staphylococcus aureus, expression of adhesion molecules, plasmin, lactoferrin, TNF-alpha and cortisol were presented. Posters were presented on the role of vitamins in immunity, deconjugate treatment, choline supplementation, lysozyme, NO, C-reactive protein and IgG1-IgG2 in sheep and goat milk.

The topic of session four, on Tuesday afternoon, was 'interactions between bacteria, immunity and therapy'. These interactions within the mammary gland were highlighted by G. Leitner (Israel), with special emphasis on the role of resident leukocytes and bacterial adhesion to milk components. The balance of forces in pathogenesis and therapy of mastitis, especially concerning E. coli and S. aureus mastitis, was presented by J. J. Lohuis (Netherlands). He discussed the several models to study these interactions. In the other lectures, results on Streptococcus uberis M-like proteins, virulence factors of E. coli and S. aureus, apoptosis of bovine neutrophils and CNS were presented. Poster presentations had the following subjects: endotoxin mastitis, pain in mastitis, different treatment strategies and exoproteins of S. aureus.

The first speaker of the 5th and last session on Wednesday 14th June about 'modulation of the mammary gland immunity' was A. Zeconi (Italy), one of the organizers of the symposium. The topic of his presentation was the present and future of immunomodulation of mammary gland immunity. His major conclusion was that none of the present immunomodulators are really effective in bovine mastitis. The last invited speaker was J. Leigh (UK) with a presentation on S. uberis vaccines and virulence determinants. He discussed several approaches to vaccination against S. uberis and the identification of new vaccine candidates through the production of genetic mutants. The last oral presentations discussed different types of vaccines developed and tested in the field with variable results. The effect of cytokines on lactating dairy cows was also discussed. Poster presentations had a wide range of subjects from mastitis prophylaxis in heifers, preventive therapy over immunomodulation through milk casein derived peptides.

In conclusion, the symposium was of high scientific value with contributions for numerous researchers and a great success with more than 200 participants from all over the world.

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BRITISH MASTITIS CONFERENCE 2001

The 14th British Mastitis Conference was held in Lancashire in the north of England close to the areas to suffer worst from Foot-and-mouth-disease partly as a measure of confidence in the recovering dairy industry. The occasion was greeted by the largest audience for some years with many new delegates taking advantage of excellent access and facilities. The programme included a record of 18 posters on topics such dry therapy, teat condition, bedding systems, the epidemiology of infection and antibiotic resistance.

The presentations started with a session on alternative approaches to treatment. Mette Vaarst, Foulum, outlined the recent history of organic dairying in Denmark. She showed the success of mastitis control in organic farms in the early 1990s. Unfortunately this has not been sustained by the more recent converts to
the system. Now the organic producers achieve no better results than the conventional farmers in terms of milk quality or clinical mastitis and tend to poorer results. This is partly attributed to the pressures of larger farms where there is too little time available for the attention to detail that previously was the hallmark of the organic producer. Stephen Turner explained the individual approach of a homeopathic veterinarian-cum-farmer. He showed results from two herds, not in controlled trials, that indicated that most benefit in treating mastitis came from frequent stripping of the quarters and cold-water bathing but not from the homeopathic treatment. He finished with a contrary view to most organic dairy farmers who use straw yards posed a much higher risk to mastitis than properly maintained cubicles. A tour-de-force came from Bill Meaney, Teagasc, Eire in his views on the TeatSeal alternative to conventional dry cow therapy. He led the audience through the early results of considerable promise, the adoption of a reformulation in New Zealand, and then the growing sophistication of the product in his hands by inclusion of the antibacterial, lactobacillus 3147.

The second session examined how was aimed to help those developing a new dairy farm. Graeme Lochhead, a designer, reviewed the complex process in planning and customising a new dairy farm. It requires integration of the needs of the cow and the work force. Extreme care and attention to detail are essential, as any mistakes are expensive in all ways. John Baines considered the requirements of a new parlour to manage mastitis. Whilst throughput is important it is secondary to performing an appropriate hygiene routine of teat preparation, stimulation and teat disinfection. Positioning of the cow's udder properly is vital to allow correct cluster hang. Achieving quality in milk production starts with the correct facilities to allow staff to carry out their tasks effectively. Eric Hillerton presented the features selected by the Institute for Animal Health for their new 500-cow farm. To control mastitis they are building sand-bedded cubicles, a 35° rapid-exit, double-18, herringbone parlour and will insist on a milking routine using 2 staff in the parlour, that gives extra time for teat preparation and disinfection. Major influences on the decisions are the need to improve staff employment conditions and the critical need to view milking cows as part of the food production industry and not traditional agriculture. Oxfordshire farmer John Gerring has his views on the need for low costs of production but recognises that these must be part of a longer-term survival plan involving the welfare of the cow and the staff. He starts from the premise of reducing stress.

The current debate that cell counts can be too low was addressed in the final session. Julie Fitzpatrick, University of Glasgow, set the scene with a tutorial on milk cells, what they do, how many and how they are controlled. Laura Green, Warwick University, reviewed a series of epidemiological studies on the mastitis relating its occurrence to the cell count of the bulk milk, the herd, the cow and the quarter. She highlighted recent work on a greater incidence and severity of coliform mastitis in low cell count cows. Gordon Swanson, a geneticist, showing benefits in the selection for breeding of low cell count cows and how this led to less mastitis presented a contrary argument. There were no obvious signs that the arguments between the two reviewers were compatible. So the issue requires further discussion and research.

Full details of the 2001 conference, manuscripts and posters, including for the preceding two years are on the web site http://www.iah.bbsrc.ac.uk/bmc. Details of future meetings are also posted there.

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WORLD DAIRY SUMMIT CONFERENCE ON ANIMAL HEALTH

Auckland, New Zealand
30 October 2001

The aim of the meeting was to discuss how animal health issue and problems could impinge on trade in milk and milk products.

Noel Murray (New Zealand) gave the main theoretical paper on 'risk analysis'. The content is the basis of the upcoming OIE Code paper. He considered how all assessment have to be transparent displaying fairness, consistency, ease, completeness and obvious reasons for the decision made. An assessment needs to include:

- the scope, the purpose, commodity and volume of trade affected; communication between interested parties;
- identification of the specific hazard e.g. pathogen and its prevalence;
- the risk assessment including means of entry, spread and possible impact firstly as a qualitative then a quantitative exercise;
- a release assessment, the likelihood of the infection crossing borders;
- a consequence assessment, for the environment, public health, production and any indirect effects;
- and finally an evaluation of the potential if the risk is considered non-negligible.

The whole exercise should be demonstrated by scenarios.

The following papers were demonstrations using scenarios. David Emery (Australia) considered 'Import risk assessment of FMD'.

Much of the risk relates to the means of spread, either the oral or aerosol route. The risk then varies with the source of the infection e.g. in stockfeed, downgraded product, human waste food or waste disposal sites. The consequence analysis significantly influences the evaluation for FMD.

Jim Cullor (US) discussed the particular problem of *Escherichia coli* 0157:H7. He related that the organism survives in farm animals and in the ecosystem, perhaps 25% farms have animals shedding this organism. Some 300-1000 human deaths annually may be related to infection by this organism following direct oral transmission of 10-1000 bacteria. It is rare to find this organism in bulk, raw milk and no cases of mastitis in dairy cows have been reported as caused by this strain of *E. coli*. Its presence in milk products is a consequence of post-pasteurisation contamination. The organism cannot be eradication
because it is too widespread in the environment, therefore it much be managed. Current diagnostic methods are very poor and not cost effective because of the high cost of monitoring and the low prevalence of detection. For the dairy system then HACCP methods should be applied, specifically targeting the teat-end of the dairy cow, proper treatment of milk and possible vaccination of dairy cows.

Treatment of milk to control bacterial presence was presented by Lindsay Pearce (New Zealand) with particular reference to Mycobacterium avium paratuberculosis. Many methods of heat or light treatment were available for raw product but easily negated by post-pasteurisation contamination. The requirement for effective methods was growing as the market insisted on 'no risk from food' and 'natural products'.

The second topic area dealt with use of computer-based systems to manage health. David Hayes (New Zealand) described the MINDA system taking field entry data on a paper notepad, but with palm systems now available, inputting to a central database. The whole system uses health data and product quality data. There is still a question on who pays particularly when the whole database can be applied to national description of the industry. Torkel Ekman (Sweden) presented the Swedish system of animal identification allowing traceability from the birth of the animal to the products on the supermarket shelf. This is somewhat limited for milk when it is commingled in a tanker and subsequently a silo. The New Zealand approach and experience in controlling bovine tuberculosis was described by Paul Livingston (New Zealand). He traced the dynamics of the problem and its geographical distribution showing clearly that the success of control was related to the budget applied. It is obvious that budgetary reductions in the 1970s were linked to a rapid spread that is still to be fully contained. The role of the wildlife reservoirs are main long-term practical limitations to fully successful control.

The final session discussed the practical and political aspects of cells in milk. Larry Smith (US), chair of the Standing Committee on Animal Health, presented the concept that abnormal milk could be well defined on the basis of cell count. Sufficient evidence exists to conclude that if the cell count of an individual quarter exceeds 200 000 cells/ml then there is an extremely high probability of infection and that below 100 000 cells/ml then it is most likely that the gland is healthy. The range 100 to 200 000 cells/ml is a 'grey' area. He was careful to emphasise that cell count limits are an indicator of suitability. Thresholds higher than 200 000 cells/ml for bulk milk indicate the proportion of infected glands that the regulator or purchaser is prepared to accept in defining what is a suitable milk quality.

Eric Hillerton (UK) reviewed EU inspection reports on compliance of EU member, and other, countries in achieving compliance with Milk Hygiene Directive 92/46. The reports indicate that broadly northern European countries comply but that there is insufficient space to show that some countries comply and it is clear that at least four member countries fall significantly short in ensuring that the milk supply conforms to the required hygiene and quality standard. Mel Schälilbaum (CH) showed clear evidence that milk that fails to meet the hygiene standard commonly required significantly reducing processing value especially for cheese manufacture. Indeed the losses start at the level of 200 000 cells/ml as discussed by Smith.

The New Zealand situation was described by Bob Franks. He reported that the New Zealand cell count was broadly in line with the major European producers and that significant progress in reducing the national cell count to now less than 200 000 cells/ml had been made since 1980. The EU standard is the clear bench mark but the drive for innovative products from milk will require even better quality milk and New Zealand will strive to have the most hygienic milk in the world, coming only from health cows.

Finally Jörn Hamann (Germany) showed new results on milk composition that underpinned the earlier papers. He can show that milk composition start to deviate in terms of all significant components as cell count increases above 100 000 cells/ml. Above this level milk becomes increasingly abnormal.

The conference produced a large amount of new and detailed information. It is fortunate that the whole proceedings, including all of the PowerPoint presentations, are available from IDF on CD-ROM.

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INTERNATIONAL COLLABORATION ON TEAT END CONDITION

An informal discussion group of researchers and udder health advisors, self-styled as the "Teat Club International" is attempting to reach international agreement on methods for teat evaluation and correct interpretation of results. This "Club" has now published a series of collaborative papers on the influence of factors affecting the short- or medium-term changes in teat condition (AABP/NMC, Vancouver 2001).

The papers include a review of factors affecting short- or medium-term changes in teats, teat skin conditions caused by infections, a protocol for systematic visual evaluation and manual palpation of teats that can be used in commercial dairies, and guidelines for interpretation of the observations. The series also throws a new light on the relationship between teat-end callosity or hyperkeratosis and the risk of mastitis.

All the new and old knowledge is put together into a short course assessing teat condition which was first held during the NMC in Orlando in 2002. The group plans to run this course at other conferences.

The members of the club are: Graeme Mein, Francesca Neijenhuis, Eric Hillerton, Bill Morgan, Ian Ohnstad, Jenks Britt, Doug Reineinemann, John Baines, Leo Timms, Morten Dam Rasmussen, Nigel Cook, Ralph Farmsworth and Tom Hemling.

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ANNUAL US NATIONAL MASTITIS COUNCIL MEETING DRAWS CROWD TO ORLANDO, FLORIDA

Individuals interested in mastitis and milk quality convened in Orlando, Florida, February 3-6, 2002 to attend the NMC 41st Annual Meeting. An excellent crowd of nearly 400 people attended the conference, which is held each year to provide a forum for exchanging information on udder health, milking management, milk quality and milk safety.

"We were extremely pleased with the turn-out this year despite the reluctance of many to travel after the 9/11 incident" said Program Chair Steve Nickerson. "It seems that the sunny, vacation state of Florida and this warm spot in the midst of winter brought people south, not to mention the terrific program, which drew members from 19 different countries. This latter point emphasizes the global nature of our organization."

The conference began Sunday with two well-attended short courses. Committee meetings and short courses were held Monday, followed by the annual poster session and general sessions on Tuesday and Wednesday. The Standing Committee on Animal Health of the International Dairy Federation met on both the Saturday and Sunday prior to the NMC general sessions.

Steve Nickerson Steps in as President

Officers are elected annually and serve one-year terms. NMC Presidents begin their term in office by serving one year as 2nd Vice President followed by a year as 1st Vice President. The 1st Vice President serves as the Annual Meeting Program Chairperson, and the 2nd Vice President is the Short Course Chairperson. The President alternates annually between an industry representative and an academic or government representative.

The newly-elected President is Steve Nickerson, Professor and Head of the Dairy Science Department at Virginia Tech University, Blacksburg, Virginia. Nickerson, 1st Vice President and Program Chair this past year, succeeds Gary Heinrich, Pharmacia Animal Health, Kalamazoo, Michigan, who was President last year. This year's 1st Vice President is Andrew Johnson, DVM, Total Herd Management Services, Seymour, Wisconsin, who was responsible for coordinating all the short courses at the February meeting. The 2nd VP is Leo Timms, Extension Dairy Specialist/Associate Professor, Iowa State University, Ames, Iowa. Timms previously served as NMC Treasurer.

Pam Ruegg, Extension Milk Quality Specialist and Associate Professor, Dairy Science Department, University of Wisconsin, Madison, Wisconsin was elected Treasurer. Paul Rapnicki, Assistant Clinical Specialist, University of Minnesota College of Veterinary Medicine, St. Paul, Minnesota, was re-elected Secretary.

New Board Elected

A year ago, the NMC Board of Directors voted to reduce the size of the Board from a maximum of 48 to 15 members. The Executive Committee was also decreased, from 15 members to five. These changes, which took effect February 2001, were instituted to streamline the NMC structure, and make the organization more responsive to member needs. The Board of Directors elected at this year's annual business luncheon is below:

Term Expiring 2003
Heather Besoff White, Dairy Management Solutions
Ann Godkin, Ontario Min of Ag, Food & Rural Affairs

Jeff Johnson, Land O'Lakes, Inc.
Norm Schuring, Westfalia-Surge, Inc.
Richard Wallace, University of Illinois

Term Expiring 2004
Andy Johnson, Total Herd Management Services
Larry Hemmingsen, DeLaval, Inc.
Paul Rapnicki, University of Minnesota
Steve Nickerson, Virginia Tech
David Sumrall, Aurora Dairy Corporation

Term Expiring 2005
Gary Heinrich, Pharmacia Animal Health
Ken Leslie, University of Guelph
Pam Ruegg, University of Wisconsin
Leo Timms, Iowa State University
Jim Winter, Alocide Corporation

Officers and Staff
President: Steve Nickerson, Virginia Tech
1st Vice President: Andy Johnson, Total Herd Management Services
2nd Vice President: Leo Timms, Iowa State University
Secretary: Paul Rapnicki, University of Minnesota
Treasurer: Pam Ruegg, University of Wisconsin
Executive Director: Anne Saeman, National Mastitis Council

The NMC Executive Committee consists of the NMC President, 1st Vice President, 2nd Vice President, immediate Past President and Executive Director. For 2002, this includes Steve Nickerson, Virginia Tech; Andy Johnson, Total Herd Management Services; Leo Timms, Iowa State University; Gary Heinrich, Pharmacia Animal Health; and Anne Saeman, National Mastitis Council.

Board members who completed their term are: Antone Mickelson, Northwest Dairy Association, and Allen O'Hara, Maryland and Virginia Milk Producers.

Luncheon Highlights
Outgoing NMC President Gary Heinrich received the "distinguished service award" from long-time NMC
member Dale Termunde (fondly referred to as "Father Time") during the annual business luncheon on Tuesday. Keith Sterner, National Mastitis Research Foundation President awarded $7500 to Drs. Fiona Maunsell and Mary Brown of the University of Florida for a research project on the mechanisms of mycoplasma infections and expression in the mammary gland. The luncheon also featured a video of the 2001 National Dairy Quality Award winners Ken and Ruby Meekhof, McBain, Michigan.

Committee Chairs Appointed

Committee Chairs are appointed at the Annual Meeting by the Board of Directors and serve three-year terms (except for the Program and Nominating Committee Chairs who serve one-year terms). Committee Chairs who completed their term include: Dick Wallace, University of Illinois (Education); Terry Mitchell, West Agro, Inc. (Long Range Planning); Antone Mickelson, Northwest Dairy Association (Residue Avoidance); Jim Dickrell, Dairy Today (Nominating); Steve Nickerson, Virginia Tech (Program Committee); and Doug Reinemann, University of Wisconsin (Machine Milking).

Newly elected committee chairs are: Warren Gilson, University of Georgia (Education); Ann Godkin, Ontario Min. of Agriculture, Food & Rural Affairs (Long Range Planning); Norm Schuring, Westfalia-Surge (Machine Milking); and Gary Neubauer, Pharmacia Animal Health (Residue Avoidance).

Committee chairs for the upcoming year are:

- Education: Warren Gilson, University of Georgia
- Finance: Bob Peters, University of Maryland
- Long Range Planning: Ann Godkin, OMAFRA
- Machine Milking: Norm Schuring, Westfalia-Surge
- Marketing & Membership: Jim Brewer, Pharmacia
- Milk Quality Monitoring: Eric Hillerton, Institute for Animal Health
- Nominating: Ann Godkin, OMAFRA
- Program: Andy Johnson, Total Herd Mngt Servs
- Research: Joe Hogan, Ohio State University
- Residue Avoidance: Gary Neubauer, Pharmacia
- Teat Dip: Tom Hemling, West Agro, Inc.

If you are interested in serving on a committee, contact the NMC office or the committee chairs directly (contact information for the chairs will be posted on the NMC website www.nmconline.org).

National Mastitis Council Research Foundation Holds Successful Mini-auction

A successful mini-auction of six items was held during the Tuesday evening reception, sponsored annually by Capitol Vial, Inc. Over $2000 was raised for the National Mastitis Research Foundation (NMRF). The funds are used for research in the area of mastitis and milk quality.

A good time was had by all, especially the contributors and donors. Sheila Craner of Capitol Vial donated two "Cows on Parade" figurines. Dr. Mel Schaellbaum of Switzerland purchased "Big Apple Cow" and Dr. Keith Sterner purchased "Blue Sky Cow". Danny and Ruth Yant of The Original Udder Singe donated a Bonnie Mohr print entitled "To-Mar-Blackstar-ET". Don Anderson purchased this print.

A signed and authenticated print by Lynn Bishop "Curious Creatures Cows", that appeared on the September 15, 2001 cover of the Journal of the American Veterinary Medical Association (JAVMA) was donated by Dr. Bob Harmon. Maureen Belsito was the successful bidder and will also receive an undistributed copy of the JAVMA magazine featuring the print on the cover. "Mothers in Waiting" a Bonnie Mohr print was donated by NMC. This print will grace the Utah residence of Dr. Bob Corbett, the highest bidder on this article.

The grand finale of the auction was a fun item – a cow tie – donated by Dr. Keith Sterner. Auctioneer Dr. Jim Jarrett, Executive Vice President of the American Association of Bovine Practitioners, was able to whip the crowd into a frenzy of bidding. The final successful bidder was a group from Arizona: Tom Thompson, Alyn McClure, Bruce Tonkin and Pat Gorden.

A full-scaled auction is being planned for next year’s NMC annual meeting in Fort Worth, Texas. Keep your eyes peeled for ways to donate and participate.

Upcoming Meetings

This summer’s NMC Regional Meeting will be held in cooperation with the Empire State Milk Quality Council on July 9, 2002 at the Holiday Inn Liverpool, in Syracuse, New York. Short courses on the day preceding the meeting are tentatively planned.

Next year’s NMC 42nd Annual Meeting is scheduled for January 26-29, 2003 in Fort Worth, Texas. The meeting is being held in conjunction with the ASAEE Dairy Housing Conference, January 29-31. A joint session, open to attendees of both conferences, is planned for Wednesday, January 29. The NMC website www.nmconline.org is a good way to keep up with NMC activities including future meetings and how to contact individuals within the organization.

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MULTIDISCIPLINARY JOINT MEETING

Mammary Gland Health and Disease

‘Immune cells and bioactive substances in function of susceptibility and spreading of infections in human and animals’

13th – 14th September 2002
Ghent, Belgium

The beautiful venue ‘Het Pand’ in the town center of Ghent (Belgium) was the meeting place for this 2-day conference on the 13th-14th September 2002, organised by E. Meyer (Belgium) and C. Burvenich (Belgium). It was a joint meeting of EU COST Network, COST action B20 – Mammary gland Biology, WG 1 & 2 and COST action 844. The meeting was attended by 60 delegates from various European countries.

The morning of the first conference day was specifically dedicated to the problem of Mycobacterium paratuberculosis in dairy cattle. The bovine immune system and its relation to M. paratuberculosis was approached genomically by P. Coussens (USA). Through the use of cDNA microarray resources gene expression profiles of peripheral blood mononuclear cells were analysed in healthy and diseased cattle. From this analysis it could be suggested that macrophages ingesting M. paratuberculosis are attempting to signal and recruit additional immune cells. Moreover, M. paratuberculosis infected macrophages attempted to prevent persistent infection through apoptosis, whereas the interaction of the intracellular M. paratuberculosis with the macrophage may lead to the prevention of apoptosis, perhaps using the TRAF signalling system. The microbial and immunological strategies for treatment of inflammatory bowel disease were discussed by L. Steidler (Belgium). The use of Lactococcus lactis, genetically engineered to produce and secrete biologically active cytokines, for in situ administration of a de novo synthesized therapeutic agent was discussed in the treatment of IBD. The difficulties in early and specific detection of M. paratuberculosis infected animals was discussed by J. Godfrid (Belgium). Although a combination of available tests were used, the ‘paratuberculosis-free’ status of an animal could not be totally certified, as this animal could be a carrier of an early, yet undetectable, infection. L. Herman (Belgium) discussed the detection of M. paratuberculosis in raw and pasteurised milk. Milk can be contaminated by faecal contamination of direct shedding from asymptomatic animals. Detection of the bacteria through bacterial culturing takes up to 12 months and is therefore not suitable for this purpose. Therefore, mRNA methods are studied actually.

The afternoon of the first conference day highlighted bioactive components in milk. The anti-cancer potential of milk lipids was presented by J. Grinari (Finland). Although the diet could account for a lot of cancer deaths, it can also contain some components that prevent cancer. Several fatty acids, including butyric acid, 13-methyltetradecanoic acid and conjugated linoleic acid have been demonstrated to possess anti-cancer effects. Other growth promoting activities of milk were highlighted by J. Smith (UK). Insulin-like growth factor (IGF) and bovine colostrum growth factor (BCGF) have been identified in milk. The nature of these growth factors and the newly identified factor may have significance in relation to the process of carcinogenesis. The possible applications of lactoferrin were the subject of the last presentation by D. Legrand (France).

The second conference day had another three items, namely neutrophil apoptosis, the acute phase reaction and the role of NF-κB in inflammation. Mechanisms of spontaneous neutrophil apoptosis were highlighted by D. Schefel-Toelner (UK). The requirement of ceramide-rich rigid rafts and acid sphingomyelinase activity were discussed in the mechanism of spontaneous neutrophil apoptosis. The different routes of neutrophil apoptosis were discussed by T. Kuijpers (The Netherlands). Apoptosis can occur through a caspase-dependent and a caspase-independent route. The caspase-dependent route involves the activation of several regulating members of the Bcl-2 family, whereas in the caspase independent route reactive oxygen production derived from intact mitochondria is essential. Proteomics, the large-scale study of the total protein content of a biological sample, in the acute phase of bovine mastitis was presented by P. Eckerle (UK). The patterns of protein expression in normal and mastitic milk showed major differences. The expression of albumin and serotransferrin were upregulated in mastitic milk, while α-lactalbumin and β-lactoglobulin were reduced. More sensitive and specific detection techniques are however required to identify minor alterations in protein components of bovine milk during mastitis. The acute phase inflammatory reaction of the bovine mammary gland was studied by R. Bruckmaier (Germany). Through RT-PCR mRNA detection of various cytokines, lipid mediators and bacteriostatic enzymes, changes were observed within hours after infection, whereas most milk proteins remained unchanged. The molecular mechanisms of NF-κB were discussed by G. Hageman (Belgium), whereas C. Desmet (Belgium) studied the nuclear NF-κB activity in human and animal models of asthma.

Besides the high quality oral presentations, the conference also had 10 poster contributions about PMN functions during Escherichia coli mastitis, influence of sex steroids on PMN diapedesis, PMN proteolytic activities in milk, new detection methods for M. paratuberculosis and study of cell apoptosis factors.

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SYMPOSIUM ON AUTOMATIC MILKING TO BE HELD ON MARCH 24-26, 2004.

Lelystad, the Netherlands

EC-granted project

In December 2000, a three-year lasting, EC-granted, project was started on the implications of the introduction of automatic milking on dairy farms. Herein, seven research institutes and six industrial companies from 6 countries (The Netherlands, Belgium, Germany, Denmark, Sweden and the United Kingdom) join their expertise and experience in order to facilitate a widespread adoption of automatic milking without undesirable side effects. The research objectives of the project are three-fold namely, 1) to identify determinants for the adoption of automatic milking, 2) to assess the implications of the adoption, 3) to generate solutions for any adverse effects.

Symposium

One of the goals of the project is to disseminate the outcomes of the project as much as possible, both during and at the end of the project. This is done by means of the project’s website http://www.automat icmilking.nl, articles in scientific and trade journals and through presentations at symposia. On March 25 and 26, 2004 a concluding symposium will be organised in Lelystad, The Netherlands. There, the results from the project will be presented and integrated with the knowledge that emerged from other studies performed all over the world. The symposium is of international character and will be held in English. Target groups are experts from research and extension organisations, dairy and milking equipment manufacturers and governmental bodies.

Informing the dairy sector

Since the research within the project is performed in co-operation with many farmers from the participating countries, but also because the outcomes are intended to be applied on farm level, it is of great importance that the dairy farmers and their advisors are informed well about the most important practical results. People working in and around the dairy sector all over Europe should have the opportunity to read about the results from the project in the most common national and local trade journals. For that purpose, a number of articles will be written (in English) and offered to agencies of agricultural media in various European countries. At location, these will have to be translated into the native language.

The articles

The symposium is intended to comprise 8 sessions, 12 key speakers, about 40 contributing speakers and a yet unknown number of poster presentations. Research papers that will be compiled in the symposium proceedings will accompany all presentations. However, the proceedings will be available only after the symposium, and the papers will usually be too specific for placing them directly in trade journals. Therefore, key speakers will be asked to write an easily readable, attractive and practical oriented summarising article about all papers to be presented on his or her knowledge area. The resulting 9 to 10 articles will be compiled and sent to publishing agencies in several European countries.

Topics to be addressed in the symposium sessions are:

• Public acceptance
  Topics covered: Conditions under which automatic milking is accepted by society at large. The role of communication in the process of acceptance.

• Milk quality
  Topics covered: effect of automatic milking on milk quality parameters, such as somatic cell count, bacterial count, free fatty acids and freezing point. Risk factors, both in the realm of management and technology.

• Definition, detection and separation of abnormal milk
  Topics covered: a new definition of acceptable milk that suits both automatic and conventional milking. How and how well (specificity and sensitivity) can milk that should be discarded be detected? Excretion patterns of antibiotic residues when milking automatically.

• Farm and system hygiene
  Topics covered: effects of hygiene management. Effectiveness of automatic cleaning ofudder and teats. Optimal system cleaning. Requirements on milk transport, storage and cooling.

• Animal health
  Topics covered: impact of changeover to automatic milking on animal health. Identification of health risks and advantages. Health management and critical points.

• Animal welfare

• Farm and herd management
  Topics covered: advantages and disadvantages of management systems with or without grazing. Demands on management support. Use of information stored.

H. Snoek and A. Meijering
Research Institute for Animal Husbandry
Lelystad, the Netherlands

H. Hogeveen
Wageningen University
Wageningen, the Netherlands
4TH IDF MASTITIS CONFERENCE WILL BE HELD IN 2005 IN THE NETHERLANDS

Since 1975, every 10 years an IDF Mastitis Seminar is held. This seminar is regarded as the worldwide event to exchange research results, knowledge and ideas on mastitis and mastitis-related issues, such as milk quality and farm management. Important aspects of the seminar are a high level and a broad angle of presentations, a meeting between fundamental research, applied research, trade and practice. Given the wide angle in which the latest knowledge on mastitis is presented and discussed, after the meeting, the attendees will have a broad knowledge on the developments in mastitis. Moreover, because of the separate sessions on subjects, attendees will have a deeper understanding of their own specific interests. Therefore, the target group are professionals interested in the subject of mastitis and the related subjects of milk quality and management. These professionals can have a background in research (more fundamental as well as applied), the dairy industry (policy makers as well as extension workers), veterinarians and extension specialists.

In 2005, the IDF Mastitis Conference will be held for the 4th time. After Kiel (Germany), Reading (UK), fixed yet, the proposed dates are the second week of June and the proposed location is Maastricht.

The venue will most likely be MECC in Maastricht. Maastricht is an internationally well known city offering good opportunities for social events. Maastricht has its own airport and is relatively close to the major international airports of Amsterdam, Düsseldorf and Brussels.

Program
The scientific program will have sessions on the following subjects:

- Indicators for milk quality
- Food safety issues
- Detection and diagnosis of mastitis
- Control
  - Chemical
  - Biological
  - Environmental
- Management
  - Welfare
  - Economics
- Control programmes
  - Various scale of farming
  - Geographical differences
- Milking technology

Within the framework of the IDF Mastitis Conference, facilities for third parties will be created to organise and execute special events. These special events can have the format of exhibitions, technical workshops, instructions, clinics for field practice, and round tables.

The first announcement is due to be sent out within the next few months.

H. Hoogeveen
Wageningen University
The Netherlands
IDF Publications on Mastitis

All documents listed below can be obtained from IDF Brussels as per address on cover

A FRESH PERSPECTIVE FOR MANAGING MILK-BORNE DISEASES
Proceedings of the Animal Health Conference

IDF World Dairy Summit 2001
Auckland, New Zealand

The Animal Health Conference in Auckland focused on the threat of milk-borne diseases. Particular attention was given to Foot and Mouth Disease Virus (FMDV), Escherichia coli (e. coli), paratuberculosis and mastitis. The aspects examined were the causes of diseases in milk, IT solutions for their surveillance, ways of reducing their prevalence, the EU legislative framework for somatic cell counts and import risk analysis.


QUANTITATIVE RECOMMENDATIONS FOR MILKING MACHINES INSTALLATIONS FOR SMALL RUMINANTS
P. Billon, N. Fernandez Martinez, O. Ronningen, F. Sangiorgi & E. Schulling

This paper proposes quantitative recommendations which take into account their own physiology, special milking routines used in the different countries, and the need for producing high quality milk. An attempt is made to provide the most accurate guidelines for construction and performance for milking machines for small ruminants in general.

GUIDELINES FOR TEST OF THE FLOW CAPACITY OF THE MILKING UNIT
IDF Standing Committee on Farm management

ISO standards for performance requirements and tests of milking machines have to cover the function and test of milking machines as well as for all member countries. Paragraph 1 of clause 16 of the ISO standard 5707 was meant as a measurement of the flow capacity of a milking cluster but turned out to be problematic and inconsistent. The document presented in this bulletin, prepared by an Action Team, describes the shortcomings of the current standard and proposes a new test method.

Bulletin 370/2002 – 42 Euro

MASTITIS NEWSLETTER N° 24

GENERAL
Report of the IDF Standing Committee on Animal health – K.L. Smith, Chairman (USA)
Note from the Editor – H. Hogeveen (Netherlands)

RESEARCH COMMUNICATIONS
Mastitis in certified organic dairy herds in Sweden – C. Hamilton, U. Emanuelson & T. Ekman (Sweden)
Studies on bovine Escherichia coli mastitis in Finland – T. Kaipainen (Finland)
Changes in milk somatic cell count with regard to the milking process and the milking frequency Preliminary report – J. Hamann (Germany)
Milking three times a day and its effect on milk production and udder health – H. Hogeveen, J.D. Miltenburg, S. den Hollander & K. Frankena (Netherlands)

MASTITIS NOTES FROM MEMBER COUNTRIES
Denmark:
The integrated cattle health and milk quality project of the Danish Dairy Board – H.J. Andersen
The Netherlands:
Implications of the introduction of automatic milking on dairy farms - A large integrated EU project is started – A. Meijering & H. Hogeveen

MASTITIS CONTROL IN MEMBER COUNTRIES
Introduction: K.L. Smith (USA), Chairman

Denmark: K. Aagaard
Finland: H. Salonieri & L. Kulkas
Germany: J. Hamann
Ireland: W. Meaney
Italy: A. Zecconi
The Netherlands: H. Hogeveen
New Zealand: M.W. Woolford
Norway: O. Østerås
Sweden: T. Ekman
Switzerland: M. Schallibaum
United Kingdom: E.J. Hillerton
United States of America: K.L. Smith

EVENTS & MEETINGS
Somatic cells in milk of dairy cows
The British Mastitis Conference 2000
Symposium on robotic milking
World Expo 2000

IDF PUBLICATIONS ON MASTITIS

Bulletin 367/2001 – 40 Euro
Mastitis Newsletter No. 25

General
Report of the IDF Standing Committee on Animal Health – K.L. Smith, Chairman
Note from the Editor – H. Hogeveen

In Memorium Frank H. Dodd
The community of Mastitis research workers and educators has lost a great colleague – K.L. Smith, Chairman
Bovine Mastitis – The significance of levels of exposure to pathogens – F.H. Dodd

Research Communications
Implications of the introduction of automatic milking on dairy farms progress during the first 12 months – Y. van der Vorst & A. Meljening
Definition of physiological cell count threshold based on changes in milk composition – J. Hamman
Relationship between somatic cell neutrophils in milk – B. O’Brien, C. Fitzpatrick, W.J. Meany & P. Joyce

PhD Thesis
Effects of bovine antibodies directed against ferric citrate receptor of Escherichia coli, feca, on bacterial iron acquisition, bacterial growth, and severity of experimentally induced bovine mastitis – K. Takemura, J.S. Hogan & K.L. Smith
Contagious and environmental pathogens: from dichotomy to sliding scale – R.N. Zadoks

Events & Meetings
International conference on the ‘Biology of the mammary gland’
IDF symposium on ‘Immunology of the mammary gland’
British Mastitis Conference 2001
World dairy summit conference on animal health
International collaboration on teat end condition
Annual US National Mastitis Council meeting draws crowd to Orlando, Florida
Multidisciplinary joint meeting
Symposium on automatic milking to be held on March 24-26 2004
4th IDF Mastitis Conference will be held in 2005 in the Netherlands

IDF Publications on Mastitis