MASTITIS
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IDF Publications on Mastitis 33
The IDF Group of Experts on mastitis (Group A2) have completed another busy year. The Group has met on two occasions since the publication of Edition 21 of the IDF Mastitis Newsletter. Meetings were held in Brussels on 18 November 1996 and in Guelph, Ontario, Canada, 20 June 1997. Both meetings were well attended. Dr Ken Leslie, University of Guelph, organized an excellent meeting in Guelph with a formal dinner and a 1-day technical tour of analytical laboratories, research farms, a breeding cooperative, and working dairies. All participants thoroughly enjoyed the tour and greatly appreciated the efforts of Dr Leslie.

Some significant changes have occurred in the structure of Group A2 over the past year. At the Annual Sessions in 1996, Commission A approved the disbanding of Subgroups A2B and A2D. Both Subgroups have been very productive over the past several years but during recent times their need to exist has diminished. Much of the work of A2D has been absorbed into Group A2 – Milking Machines – chaired by M. Rasmussen (DK). As a result of the disbanding of A2B and A2D, Group A2 meet for a brainstorming session in Brussels on 17 November 1997. The purpose was to identify new action units that would best accomplish the objectives of A2. The A2 membership agreed to organize into “action units” around the following nine topics:

1. Control schemes – to describe the actual control schemes used in the various member countries – L. Smith (US) rapporteur;
2. Mastitis therapy – to define and clarify the objectives for mastitis therapy – E. Hillerton (UK) rapporteur;
3. Economics – to determine and define the economic issues surrounding mastitis – J. Reichmuth (DE) rapporteur;
4. Vaccination/immunology – to review the current knowledge and future prospects for immunization and our understanding of the immune mechanisms of the cow – A. Zecconi rapporteur;
5. Promotion – to develop effective mechanisms to disseminate the activities of A2 to interested parties on an international basis – M. Woolford (NZ) rapporteur;
6. Cell counting/other markers of inflammation – to monitor the accuracy and adaptability of various methods of measuring inflammation including somatic cell counting – A. Saran (IL) rapporteur;
7. Susceptibility – to determine factors that influence the susceptibility to intrammary infection and mastitis – J. Hamann (DE) rapporteur;
8. Diagnostics – to determine new methods for diagnosis of intrammary infection – U. Vecht (NL) rapporteur;

Two major publications were published in the Bulletin No. 321/1997. The first was titled, “Recommendations for Presentation of Mastitis-Related Data. Part 1: Somatic Cell Count. Part 2: Records of Clinical Mastitis”. This document was prepared by a small group under the leadership of Dr O. Østergaard (NO) and recommends standardized methods for summarization and presentation of somatic cell count data. This is important as milk somatic cell counts are increasingly used to compare milk quality within regions or states, or a country as well as among countries. The final number used to indicate the status of a country/region/milk cooperative can vary greatly depending upon the method used for calculation. As the demand for such comparisons increases with increased world trade in milk and milk products, so does the need for a standardized method of calculation. In addition to the somatic cell count data, the document also deals with presentation of clinical mastitis data as these data also suffer from a lack of consistent method of presentation, and comparisons among studies or reports are very different.

The second publication the Bulletin No. 321/1997 was titled, “Guidelines for Evaluation of the Milking Process” and was prepared by the former Subgroup A2D under the leadership of Prof. J. Hamann (DE). The paper describes guidelines for evaluating the entire milking process. The guidelines are based mainly on evaluation of the following criteria: (1) operator action and behaviour; (2) animal factors and behaviour; (3) machine characteristics, and (4) general conditions of housing and management. Application of the guidelines will result in detailed information on interactions between machine, milker and dairy cows, and the related efficiency of milking, milk removal and any risk of new infection of the mammary gland.

A third publication has recently been approved for publication in the Bulletin by Commission A. This publication is titled, “Evaluation of the Electrical Conductivity of Milk as a Mastitis Indicator” and was prepared by Dr A. Zeecon (IT) and Prof. J. Hamann (DE). The manuscript is a detailed analysis of the published literature on the use of electrical conductivity to evaluate mastitis in dairy cows and should prove useful to those interested in milking equipment and automation in the milking process.

The IDF Mastitis Newsletter No. 21 was published in September 1996 and contained a wide range of articles relating to mastitis control and the production of quality milk. The Newsletter is edited by Prof. M. Schäffelbaum (CH). Newsletter No. 21 was the last edition to be published as a “stand alone” publication. The current and future editions will be published as a part of the Bulletin. The Mastitis Research Index will be updated and published in 1998. Both a hard copy and an internet version are envisioned by the editor, Prof. H. Saloniemi (FI).

Other topics discussed at meetings include regular updates on the current activities and future meetings of the US National Mastitis Council by Prof. L. Smith (US). Several A2 members participated in the special session of the NMC Annual Meeting held in February 1997 in Albuquerque, New Mexico. The special session was “Milk Production: Hazards and Risks from Microbial Pathogens and Chemical Residues”. Dr K. Leslie (CA) organized a special seminar in conjunction with the A2 meeting in Guelph, Ontario, Canada, on the topic of “Environmental Strepococci and Mastitis Control”. A2 has agreed to sponsor a Year 2000 Seminar on the specific topic of “Udder Defenses and Immunology”. The seminar is being organized under the leadership of Dr A. Zecconi (IT) and will be held in Milan, Italy.

Some changes in membership have occurred since the publication of Bulletin 21. Prof. V. Porta (IT) and Dr Ch. Nystedt (SE) have left the group. New delegates include Dr K. Aagaard (DK), Dr E. Cifrian (ES), Dr H. Hoogeveen (NL), and Mr T. Kazama (JP). We welcome our new colleagues and would like to thank those who are leaving for all of the hard work, fruitful discussions, and comradeship over the years.

Prof. K. Larry Smith, Chairman
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September 1997
DIFFERENTIAL SOMATIC CELL COUNTS IN MILK

Somatic cell counts in milk is a widely used marker of udder health and milk quality. Somatic cells represent the second line of defence, the first being the anatomical and chemical barriers of the teat apex and teat canal.

The resident cells of the healthy mammary gland, mainly leukocytes, initiate the inflammatory response. When pathogens pass the teat canal barrier, those cells together with PMNs recruited from the blood, are necessary to eliminate the invading organisms. Both the resident leukocytes in the udder and those recruited from the blood are involved in the response to pathogen invasion and its eventual evolution into a chronic infection stage.

The distribution of leukocytes among the different cell types in milk changes in relation to the status of infection in the mammary gland. At the National Mastitis Reference Center (NMRC), we are trying to define a procedure for the determination of immunocell types in milk, using monoclonal antibodies and analysing the cell populations by flow cytometry. The flow cytometry method allows for the differentiation of B and T lymphocytes and the definition of activation or deactivation of macrophages and PMN cells via the labelling of surface receptors by specific monoclonal antibodies. The correlation between PMNs counted by light microscopy and that determined with monoclonal antibodies by flow cytometry was high (r = 0.94). An interesting result of trials carried out at the NMRC is that while a high variability in total SCC was observed between milk samples taken at different milking times (fore-milking, mid-milking and residual milk), or at different milking times, the leukocyte sub-population patterns remained stable. The importance of strictly defined sampling and experimental design has to be stressed, when a high repeatability and sensitivity are the goal, mainly in research trials. In healthy, uninfected udder quarters, no significant variation of leukocyte populations was found between quarters within cows. A high variability however was found among cows.

The consistency in the numbers as well as percentages found in milk samples collected from 44 quarters with the same bacteriological status during a period of 3 months, may indicate high heritability. Whether this observation repeats itself on infected quarters with different udder pathogens is unknown, and further investigations are being conducted in samples taken from artificially infected quarters and from routine examinations of commercial herds.

**ERRATUM**

**MASTITIS NEWSLETTER 21**

Antimicrobial Drug Policy in 4 Nordic Countries

K. Plym Forshell, O. Østerås, K. Aagaard & L. Kukas

Correction on page 27, Figure 4: "Incidence of clinical mastitis in the Nordic countries":

The incidences of mastitis in Denmark for the years 1993, 1994 and 1995 have been 0.56, 0.54 and 0.53, respectively.

Karsten Aagaard
Danish Dairy Board, Frederiks Allé 22, DK-8000, Aarhus C, Denmark

EFFECT OF UNDER-MILKING AND OVER-MILKING ON TEAT TISSUE CONDITION

The objective of the study was to monitor the effect of controlled undermilking and overmilking on external teat-end condition and on changes in internal teat condition of cows from mid-lactation until drying-off. Sixty-three cows, with a mean interval of 91 days postpartum, were randomly assigned to three groups. For cows in the control group (T1), the clusters were automatically removed when milk flow reached 0.2 kg/min. The clusters in the under-milked group (T2) were manually removed when milk flowrate dropped to 0.8 kg/min. The clusters in the over-milked group (T3) were removed 2 min after milk flow reached 0.2 kg/min. The internal changes in teat structure were measured with an ultrasonic transducer. The mean teat-end condition of cows in group T2 was significantly better (P<0.05) at each monthly assessment than for the other groups (Table 1). However, removal at this flowrate reduced the mean milk yield of cows in this treatment by 5%. The mean increase in teat wall thickness during milking was not significantly affected by treatment. The diameter of the teat cistern, the length of the teat canal or length of the teat measured before and after milking were similar for the three treatments.

Table 1: Mean teat-end scores for front and hind teats for three treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean Teat-End Score (1–6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0</td>
<td>2.34 1.72 2.03 0.173</td>
</tr>
<tr>
<td>Day 30</td>
<td>1.88 1.57 2.00 0.166</td>
</tr>
<tr>
<td>Day 60</td>
<td>1.88 1.41 1.94 0.179</td>
</tr>
<tr>
<td>Day 90</td>
<td>1.87 1.49 1.85 0.168</td>
</tr>
<tr>
<td>Day 120</td>
<td>1.92 1.57 1.91 0.167</td>
</tr>
<tr>
<td>Day 150</td>
<td>2.01 1.54 1.96 0.167</td>
</tr>
</tbody>
</table>

* P<0.05 ; ** P<0.01.

In conclusion, there was no difference between overmilking for 2 min and milking with automatic cluster removers in either teat-end condition or in changes in teat structures but teat-end condition was improved by undermilking.

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\(^2\) Research Institute for Animal Husbandry, Runnderweg 6, Lelystad, the Netherlands
EFFECT OF VARIOUS MILKING MACHINE SYSTEMS ON FREE FATTY ACID DEVELOPMENT IN MILK

In continental Europe, low-level milking systems and large bore milkins are generally recommended in order to maintain low free fatty acid (FFA) levels in milk. However, low-line systems are considerably more expensive as units have to be doubled-up and large bore milkins can result in plant hygiene problems. This study investigated the influence of three milking machine systems on FFA level of milk; (i) milking through a recorder plant (38 mm milkins at 1.5 m above cow standing level, float valves in recorder jars, vertical receiver jar and intermittent pumping), (ii) milking direct-to-line (63 mm milkins at 1.5 m above cow standing level, horizontal receiver jar and intermittent pumping), and (iii) a bucket milking system (simulating a low-line plant).

Three groups comprising nine cows each were milked through each system for a 2-day period. Milk from each treatment group was collected separately and sampled at a.m. and p.m. milkings. A composite sample was also formed from the bulk milk from each treatment group based on a.m. and p.m. milk yields. Milk samples were stored overnight at 4°C and analysed for FFA content on the following day. The results are presented in Table 1.

The direct-to-line milking system resulted in higher milk FFA levels than the bucket system at a.m. and p.m. milking and for the total daily milk. The recorder system had high FFA levels compared to the bucket system at p.m. milking. In conclusion, when installed and operated correctly, the recorder milking plant did not increase FFA levels of total daily milk compared to the bucket milking plant or the direct-to-line system with a 83 mm milidine.

B. O'Brien, E. O'Callaghan & P. Dillon
Teagasc Research Centre, Moorepark, Farnoy, Co. Cork, Ireland

The Use of Lactacin 3147 in Mastitis Control

In a joint collaboration between Teagasc Dairy Research Centre at Moorepark and University College Cork a number of new bacteriocins have been isolated and characterized [1]. One of these, lactacin 3147 (patent pending) is a broad-spectrum bacteriocin produced by Lactococcus lactis DPC3147 which, like nisin, inhibits a wide range of Gram-positive bacteria including lactobacilli, cistridia and listeriae. L. lactis DPC3147 was isolated from Irish kefit grains which are used domestically to sour milk for bread-making. Genetic studies involving PCR and DNA hybridizations revealed that lactacin 3147 is not related to nisin. Like many other bacteriocins produced by lactic acid bacteria, lactacin 3147 is heat stable, particularly at low pH, and is produced during logarithmic growth of the producing strain. This bacteriocin has also been evaluated for its potential applications in a number of food systems.

Recently the antibacterial action of lactacin 3147 was compared with the well-known bacteriocin, nisin, against a range of mastitis-causing pathogens. The results showed that lactacin 3147 was effective in inhibiting both staphylococcal and streptococcal strains and appeared to be more effective against streptococci than staphylococci when compared to nisin (Table 1).

Since lactacin 3147 was shown to be effective in killing mastitis pathogens in vitro, the potential for incorporating the bacteriocin into a teat seal formulation was investigated with a view to developing a non-antibiotic based product for preventing new infection in dry cows. This phase of the work was carried out in cooperation with a commercial partner, Cross Vetpharm Group Ltd, who manufacture teat seal. The commercial teat seal formulation contains heavy inorganic salts in a mineral oil base and is indicated for intramammary infusion after the last milking of the lactation. It is instilled from a plastic syringe of a type similar to the syringes which are used for infusing antibiotics, and forms a physical plug in the teat sinus and canal. The treatment is used to prevent the establishment of new infection during the dry period. Lactacin 3147 was incorporated into the seal, thus localizing the bacteriocin in the teat and providing an additional antibacterial barrier to infection.

Table 1: Effect of milking system on FFA development in milk

<table>
<thead>
<tr>
<th></th>
<th>Recorder plant</th>
<th>Direct-to-line plant</th>
<th>Bucket plant</th>
<th>s.e.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.m. milking</td>
<td>0.603</td>
<td>0.695</td>
<td>0.545</td>
<td>0.0594</td>
</tr>
<tr>
<td>p.m. milking</td>
<td>0.845</td>
<td>0.872</td>
<td>0.724</td>
<td>0.0383</td>
</tr>
<tr>
<td>Total daily milk</td>
<td>0.688</td>
<td>0.756</td>
<td>0.590</td>
<td>0.0608</td>
</tr>
</tbody>
</table>

Table 1: Sensitivity (size of zone of inhibition) of mastitis strains of streptococci and staphylococci to a lactacin 3147-producing and a nisin-producing organism [0 to 1 mm (-); 1 to 5 mm (+); 5 to 15 mm (+++)]

<table>
<thead>
<tr>
<th>Strain</th>
<th>Lactacin 3147 producer</th>
<th>Nisin producer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streptococcus agalactiae B</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Streptococcus agalactiae H</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Streptococcus agalactiae P</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Streptococcus faecalis I</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Streptococcus uberis L</td>
<td>++</td>
<td>+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Staphylococcus aureus (sub-species)</th>
<th>Lactacin 3147 producer</th>
<th>Nisin producer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>11</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>13</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>89</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>10</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>1</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>22</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>32(a)</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>36</td>
<td>+</td>
<td>++</td>
</tr>
</tbody>
</table>

1 Broomhill Road, Tallaght, Dublin 24.
Teat seal preparations containing 2000–17 000 AU/ml of lactacin 3147 were prepared and assayed using an agar well diffusion technique. This involved mixing the seal, the bacteriocin and a surfactant to form an emulsion. The combined formulation exhibited excellent antibacterial action against *Streptococcus dysgalactiae* (Figure 1).

Studies are now in progress to evaluate the effectiveness of the formulation in vivo.

**Figure 1: Teat seal containing lactacin 3147 plus surfactant. The Figure shows wells containing the modified teat seal in an agar plate seeded with *Streptococcus dysgalactiae*. The zones of inhibition around the wells are due to inhibition of the mastitis pathogen by the bacteriocin when incorporated in the seal.**

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**DECISION-MAKING IN CLINICAL MASTITIS THERAPY PROGRAMMES**

Mastitis continues to be the most costly disease condition that faces dairy producers [1], despite the fact that over the past two decades great advances have been made in the control of contagious mastitis. Mastitis is the number one cause of antibiotic use in the dairy cow [2]. In Wisconsin, 82% of the antibiotic residue violations in 1991 were related to the treatment of mastitis [3]. The use of post-milking teat dip and total dry cow therapy have had a considerable impact on the levels of contagious mastitis caused by the major pathogens, *Streptococcus agalactiae* and *Staphylococcus aureus*. This has resulted in a drop in the bulk tank somatic cell counts (BTSCC) in many countries with a developed dairy industry. Comprehensive studies have documented that decreasing BTSCC has been associated with increased milk production and improved milk quality [4,5]. However, many dairy producers have been disappointed because the incidence of clinical mastitis has not decreased along with the improved BTSCC. In fact, many herds with low BTSCC have substantial clinical mastitis rates [6].

Most clinical mastitis cases on farms which have controlled *S. agalactiae* and *S. aureus* are caused by organisms which are found in the cow’s environment. The predominant organisms involved are the environmental streptococci (sometimes referred to as *Streptococcus non-agalactiae*), and the coliforms. In 1990, Bennett [7] documented changes in the etiology of clinical mastitis on one California dairy over a 24-year period. A gradual switch from clinical mastitis caused by contagious organisms to cases caused by environmental agents was observed. Despite a dramatic decrease in contagious pathogens, there was only a moderate change in the rate of clinical mastitis throughout the time period. There was a modest decrease in the incidence of clinical mastitis as the herd went from a high BTSCC to a level of less than 150 000 cells/ml. In contrast, Erskine et al. [8] found that herds which had controlled contagious mastitis, as evidenced by a herd average SCC of <150 000/ml, had a higher level of clinical mastitis than did herds with severe contagious mastitis problems (average SCC of >700 000/ml). It is apparent from these data why some dairy producers have become frustrated with the occurrence of clinical mastitis.

Further difficulties arise in the understanding and management of clinical mastitis problems, as a result of the lack of good records [9]. The collection of milk samples from clinical cases, and use of a system of pathogen identification, may encourage more accurate record-keeping. At the farm level, adequate records aid in the identification of risk factors by allowing epidemiological examination of previous mastitis cases [3]. Such records help to indicate appropriate management of clinical cases in a particular dairy operation.

Clinical mastitis is an economically important disease. Although traditionally it has been stated that subclinical mastitis is responsible for 70% of the losses associated with mastitis, the changing patterns of infection make this statement debatable. Certainly, on farms which have controlled contagious mastitis, as evidenced by low BTSCC, clinical mastitis is more economically relevant. In the US, losses per clinical case have been estimated at $107 [1]. Six main factors have been noted to contribute to this loss. These include lost production, milk withhold, premature culling, increased labour, costs of therapy and veterinary services, and decreased genetic improvement. Eighty-eight percent of the economic loss associated with clinical mastitis has been attributed to lost production and loss of milk sales due to withhold times [10]. Pluri-parous cows lost 2.1 times as much as first-calve heifers, and cows <150 days in milk (DIM) lost 1.4 times more than cows >150 DIM [10]. Losses of 4–5% of lactational production are common [3]. Bartlett et al. [9] noted a 341 kg loss in the 60 days after clinical mastitis. Lucy & Rowlands [11] noted a 540 kg drop in production associated with clinical mastitis. Bennett [7] noted an acute loss of 260 kg per case, due to milk withholding, and a further lactational loss of 454 kg. Bartlett et al. [9] found that production loss was not strongly associated with the agent, although others have found that *E. coli* is associated with greater losses [3]. Generally, investigators agree that the production loss is most evident in the first 60 days after a clinical episode, after which lactation curves return to pre-infection predictions. High production was seen to be a risk factor for clinical mastitis in pluri-parous cows, but not in heifers [10].

Appropriate therapy of clinical mastitis remains a contentious issue. Gutberlet et al. [12] found no difference in clinical or bacteriologic cure rates in cases treated with antibiotics (amoxicillin or cepahaprin) versus those treated

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**Literature**

2. M. Ryan¹, W.J. Meaney², C. Hill² & P. Ross²
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   ² Microbiology Department, University College Cork, Ireland
with oxytocin. Cases used in the study were mild episodes of clinical mastitis without systemic clinical signs. On bacteriologic culture, 37% were coiforms, 26% environmental Strep sp and 24% had no growth. Hallberg et al. [13] reported on a series of studies with the new lincosamide antibiotic “pirilmycin”. Cases treated with pirilmycin were more likely than untreated controls to return to normal milk by the 23rd milking post-treatment. Higher bacteriologic cure rates were observed in pirilmycin-treated cases caused by Gram-positive organisms than in untreated controls (58% versus 27%). No change was observed in cure rate of treated Gram-negative infections over spontaneous cure rates. Although Gutterbock et al. [12] found that the oxytocin and antibiotic groups had similar clinical and bacteriologic cure rates, the economic advantage of not treating was lost over the entire lactation because of the higher relapse rate in the oxytocin group [14]. While the short-term outcomes were similar, there may be long-term benefit to treating with antibiotics. Many of the relapses occurred in the cases with environmental Streptococcal infections [12]. For this group of bacteria, there may be definite benefits to using antibiotic therapy [15]. A significant proportion of clinical mastitis cases fail to yield growth on bacteriologic culture. This is particularly true in low BTSCC herds, where rates of no growth from clinical cases ranged from 15 to 40% [16]. There is no intramammary therapeutic agent approved for the treatment of mastitis caused by coiform bacteria. In light of these facts, it would appear to be logical to target antibiotic use at Gram-positive cases of clinical mastitis.

In a recent Ontario study, Sargent et al. [16] reported on clinical mastitis rates and on the distribution of causative organisms. In this study, 2840 complete cow lactations were followed. The overall lactational incidence of mastitis was 19.8%. In other words, one out of five cows had at least one case of mastitis during its lactation. The 65 Ontario dairy herds studied had lactational incidence rates varying from 0% to 58.3%. The lactational incidence increased with age of cow and the majority of cases were treated early in lactation. The clinical severity of the mastitis did not accurately indicate the organism involved. However, coiform agents and no growth were most common in cases classified as severe. When all cases are considered, the distribution of causative organisms cultured is shown in Figure 1. Approximately 40% of the cases were caused by coiform agents or yielded no bacterial growth [16]. These cases

![Figure 1: Pathogens present in cases of clinical mastitis.](image)

would be targeted for a non-antibiotic therapeutic regimen.

Craven [18] commented that upon recognition of a case of clinical mastitis a herdsman must decide whether to treat, when to treat, how to treat, and whether to seek veterinary advice. An informed decision would require knowledge of the agent involved, and the history of infection of the cow. Chaming [17] found that while the clinical cure rates for cases without therapy were relatively high, the bacteriologic cure rates were low (20%). During a 1-year trial period, only 13% of initially untreated cases of clinical mastitis were selected for an antibiotic treatment due to worsening clinical signs. However, the average BTSCC rose, indicating an increase in the prevalence of subclinical infection. The author speculated that a ‘no treatment’ policy for clinical mastitis would lead to an increase in subclinical mastitis and the associated milk loss. Erskine [18] stated that therapeutic regimes to ameliorate the effects of clinical mastitis are warranted on economic and ethical bases. He noted three criteria which therapeutic protocols must fulfill in order to be considered viable options:

- Treatment must reduce the magnitude or duration of infection
- Drug residue information must be available
- Treatment must be cost effective

Current therapeutic agents were found to be lacking with respect to clinical coiform mastitis on all three criteria. On the other hand, treatment protocols which address the first two criteria are available for Gram-positive cases, but their cost effectiveness is uncertain.

Recent popular media campaigns have suggested a rise in antibiotic resistance of bacteria known to be human pathogens. Attempts to link these changes to antibiotic use in agriculture should not be overlooked. The public are demanding more targeted use of medicines in animals. In this respect, it is noteworthy that in herds which have effectively controlled contagious mastitis, one-third of the cultures from cases of clinical mastitis yield no bacteriologic growth. A further one-third of cases are caused by Gram-negative organisms, for which present antibiotic therapies lack efficacy. In view of these facts, a targeted therapeutic programme is appealing. Timely and accurate diagnostic tests are needed to differentiate cases caused by Gram-positive organisms, from those caused by Gram-negative agents or having no growth. Tests which can be used on-farm are required to make such targeted therapy programs feasible. Targeted antibiotic therapy programmes must show an economic benefit, in order to be widely adopted by the dairy community.

The use of the HyMast® diagnostic kit may provide the necessary etiological information, in a timely fashion, to aid in rational and targeted use of antibiotics by dairy producers. This rapid bacteriologic culture system consists of selective growth media embedded on plastic plates within a sterile plastic tube, and employs a simple incubator. Leslie et al. [19] reported that the test kit had a sensitivity/specificty for identifying Gram-positive and Gram-negative organisms of 0.80/0.76 and 0.60/0.98, respectively [18]. In this evaluation, HyMast® was compared to a gold standard of culture in a milk quality laboratory using the techniques recommended by the National Mastitis Council. Further information is needed on the value of
the HyMast® test in an integrated clinical mastitis management protocol. The impact of a targeted therapy programme on clinical cure, bacteriologic cure, relapse rates, as well as measures of economic loss should be generated. The economic losses are associated with both acute (due to withheld) and chronic (due to lost production potential) milk production deficits.

In summary, there has been an important shift away from the paradigm of unimammary antibiotic therapy at the first recognition of clots in the milk. With the development of effective aids to decision-making, a rational targeted approach to therapy of clinical mastitis has great promise.

**Literature**


**VACCINATION AGAINST COLIFORM MASTITIS: A HISTORICAL PERSPECTIVE**

Coliform bacteria are Gram-negative, non-spore-forming, aerobic and facultative anaerobic, rod-shaped bacteria that ferment lactose with the production of acid and gas within 48 h at 35°C. Genera classified as coliforms are Escherichia, Klebsiella, and Enterobacter. Escherichia coli and Klebsiella pneumoniae are the coliform species most commonly isolated from intramammary infections and E. coli is the predominant coliform species reported as causing intramammary infection in most studies [1]. In addition to the coliform bacteria, other Gram-negative bacteria such as species of Serratia, Pseudomonas, Proteus, and Citrobacter also infect the bovine mammary gland and cause clinical cases of mastitis.

Coliform bacteria are a significant cause of environmental mastitis in dairy herds and their relative importance in dairy herds has increased with the advent of effective control procedures for the contagious pathogens Staphylococcus aureus and Streptococcus agalactiae [2]. While the prevalence of coliform intramammary infection at a point in time in dairy herds seldom exceeds 1–2% of mammary quarters, they are frequently the leading cause of clinical mastitis in well-managed dairies with low bulk tank somatic cell counts. Coliform bacteria are typically isolated from 20–40% of clinical cases occurring in herds and they generally account for the majority of peracute cases of clinical mastitis in herds [3].

Control of coliform mastitis has historically been dependent upon reduced treat-at-exposure to the pathogen in the environment of the dairy cow. Control efforts concentrate on the use of inorganic bedding materials, limiting exposure to muddy or manured covered areas, and milking clean, dry teats and udders [4]. Control of coliform mastitis through increased specific immunity was thought not to be possible until the late 1980s as no common virulence factor associated with the coliform bacteria had been identified.

In 1988 Tyler et al. [5] reported that dairy cows with low naturally occurring titers recognizing the mutant E. coli strain J5 experienced a five-fold increase in the risk of clinical coliform mastitis. Escherichia coli strain J5 is a genetically stable UDG-4-epimerase-deficient R, mutant that was derived.
from E. coli 0111:B4. Escherichia coli J5 is a rough mutant that is unable to attach the oligosaccharide side chain ("O" or somatic antigen) to the core oligosaccharide–lipid A complex (common core antigens) associated with the outer membrane of all Gram-negative bacteria. This macromolecule referred to as lipopolysaccharide (LPS) or endotoxin is an integral part of the outer membrane of Gram-negative bacteria and is at least partially responsible for the clinical nature of coliform mastitis. While the "O" antigens are extremely heterogeneous, the common core antigens possess striking chemical, structural, and immunologic homology across strains, species and genera of Gram-negative bacteria.

Gonzales et al. [6] first reported that immunization with a whole cell bacterin of E. coli J5 significantly reduced the incidence of clinical cases of coliform mastitis under conditions of natural exposure. Subsequent studies by Cullor [7] and Hogan et al. [6] confirmed the report of Gonzales et al. [6]. Interestingly, the study reported by Hogan et al. [8] found no difference in the rate of new coliform infection between vaccinated and unvaccinated cows. However, only 20% of coliform infections became clinical in vaccinated versus 67% in unvaccinated controls.

Two experimental challenge trials [9,10] failed to show protection against the establishment of infection and all challenged cows developed clinical mastitis. However, Hogan et al. [9] found that infections in vaccinated cows were less severe. Vaccinated cows had lower peak numbers of E. coli in infected quarters, and lower rectal temperatures than unvaccinated controls. In addition, milk production and feed intake were more depressed in controls than in vaccinated cows. A second experimental challenge trial reported by Hogan et al. [11] employed a strain of E. coli known to cause a mild form of clinical mastitis. Results from this trial again revealed that vaccination did not prevent the establishment of infection but vaccinated cows had infections of reduced duration and reduced local signs of clinical mastitis.

The mechanism(s) by which immunization reduces the incidence of clinical mastitis in natural exposure trials and the severity of infection in challenge trials is not known. Protection is thought to be afforded by immunoglobulins specific for the core region of the LPS molecule which is structurally conserved among Gram-negative genera. The core region is exposed on Rf mutants and is thought to be exposed immediately after division of the bacterial cell prior to the complete synthesis of the outer "O" oligosaccharide side chains. Protective mechanisms suggested include: (1) core LPS antibodies neutralize the toxic effects of LPS; (2) increased complement-mediated bacteriolysis; and (3) core LPS antibodies promote clearance of LPS and/or Gram-negative bacteria through opsonization and enhanced phagocytosis. Infusion of low levels of endotoxin into mammary quarters of vaccinated and unvaccinated cows resulted in elevated somatic cell counts and no differences were observed between the two groups of cows (K.L. Smith & D.A. Todhunter, unpublished observations, 1985). These studies provided no evidence for endotoxin neutralization as the means of protection in vaccinated cows. There is no evidence of increased complement-mediated bacteriolysis.

Hogan et al. [12] have reported enhanced opsonization by serum from vaccinated cows and the enhanced opsonization coincided with high serum IgM titers to E. coli J5. A trend for enhanced opsonic activity of colostrum from vaccinated cows was noted in these studies, and colostrum and milk collected 21 days after calving from vaccinated cows had higher IgM titers to E. coli J5 than did mammary secretions from control cows. A working hypothesis is that improved opsonization leads to reduced bacteria numbers, less severe infections, and subsequently a reduction in clinical cases of mastitis. Cost-benefit modeling indicates vaccination is an economically sound strategy on well-managed dairies with clinical coliform mastitis problems [13].

Currently, there are three core antigen vaccines commercially available in the US. Two of these vaccines are based on E. coli J5 and the third is based on an Rf mutant of Salmonella typhimurium [14]. A recent survey by the National Animal Health Monitoring Survey indicated that approximately 54% of the cows in the US were being immunized with one of the three available vaccines.

**Literature**


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Mastitis Notes from Member Countries

ITALY

STAPH. AUREUS: A PROBLEM FOR ITALIAN DAIRY HERDS

The Italian dairy industry has changed a lot in the past decades. The number of dairy cows has decreased, while milk yield has increased. Indeed, milk yield in the three major Italian breeds has shown an increase of 25% in the past 10 years, with an average production of 7500 kg (305 days) for Italian Holstein (Frisona Italiana) [1]. The changes in milk production are reflected in the changes for mastitis aetiology. Our Institute has dedicated a large part of its activity to mastitis research and acts as an advisor to both farmers and practitioners; data on intramammary infections have been collected since 1952. The prevalence of intramammary infections in the dairy herds showed a sharp decline from 1973, when 65% of quarters were found infected, to 1996, when only 30% were infected. On the aetiology side, a decline of S. agalactiae infections (40% in 1956; <2% in 1996) can be observed, while Staph. aureus has risen from 10% in 1973 to 35% in 1996.

Many reasons could explain this increase:
- the increased number of cows/ herd as a consequence of the purchasing of cows (some of them infected);
- an increased frequency of animal transportation (for commerce or exposition) at both local and national level;
- the biological selective pressure as a consequence of widespread use of antibiotics;
- an increase in the quality requirements which decrease the accepted level of somatic cell counts, therefore bacteriological investigations are performed more frequently;
- increased cow performance, not coupled with a parallel increase in health management.

Staph. aureus, being a contagious pathogen, has a well-know pathogenicity. Moreover, it has a peculiarity which makes it even more dangerous. Staph.
DAILY SOMATIC CELL COUNT TESTING

INTRODUCTION
Farm bulk milk supply in New Zealand has traditionally been analysed for somatic cell count (SCC) three times per month. Seasonal average levels had been reducing over several years and were stable at approximately 200,000 cells per ml. Some dairy companies wished to make further progress and a per consignment analysis was introduced in the 1990/1991 dairy season. The dairy season in New Zealand is from 1 June through to 31 May.

HISTORICAL
New Zealand has a long history in SCC management. Initial programmes involved milk analysis using the Rolling Ball Viscometer. The Five Point Plan was promoted to farmers as a means of controlling SCC levels. Despite these efforts the seasonal average SCC level for most dairy companies in 1989/1991 was over 400,000 cells per ml. New Zealand has an extremely seasonal pattern of milk production due to the pasture-based feeding. Most of the national herd is not producing milk over winter, May, June, July. Concentrated calving occurs in July and August. Peak milk flow is in late October after which milk production declines through summer until virtually all cows are dried off in late autumn. The daily milk volumes collected by dairy companies in late October are 40 times those in June. This has traditionally produced a pattern of high SCC levels early in the season, with a lowering mid season, followed by an elevation as milk volumes decline towards the end of the dairy season.

It was decided there needed to be some degree of national coordination if mastitis was to be effectively managed across the entire dairy industry. The National Mastitis Advisory Committee was formed to act as a central forum for assembling and disseminating information to the farming community. A national plan was developed and promoted to farmers. It was called the SAMM Plan (Seasonal Approach to Managing Mastitis). It split the dairy season into five sections and identified the key management issues for each section. The five sections were: Late Lactation Period, Drying Off Period, Dry Period, Calving Period and Lactation Period. The SAMM Plan was produced in booklet form and sent to all dairy farmers.

Most dairy companies introduced advisory testing, then penalty testing, with most testing at a frequency of three tests per month. Penalties were applied for individual levels of 400,000 cells per ml or greater. In most cases the seasonal average reduced to just above 200,000 cells per ml. Testing was conducted using the Foss Electric Fossomatic technology. Some dairy companies wished to make further progress and evaluated moving to per consignment testing for SCC levels. A limited study was conducted over two dairy seasons to evaluate the effects. For the 1996/1997 season three dairy companies moved to per consignment testing using the Foss Electric Flow Cytometry technology.

DAILY TESTING
The New Zealand Dairy Group of Companies (6140 farmers, 43% of New Zealand's milk supply) is one of the companies practising daily testing. Every milk consignment for the season is sampled at the farm tank level and tested for SCC levels. Penalties are applied for any result of 400,000 cells per ml or greater. The delivery of results to the farmer in a timely manner is very important. A sample is taken from the farm and the SCC result for that consignment is delivered in a printed form back to the farm 48 h later. Where a penalty result is obtained (400,000 cells per ml or greater) a talking computer is used to phone that farm and advise of a penalty some 12–24 h before the printed form is delivered to the farm. This allows a farmer to take remedial action earlier than would normally be the case.

Part way through the dairy season all farms are supplied with a printed graph of their individual SCC results. It also shows the company average distribution and that farm’s ranking in the overall company. The whole philosophy is to supply management information to the farmer than simply test results.

FARMER RESPONSE
Farmer response is very positive. There is a small minority who expressed initial concern, but the vast majority are appreciative of having daily trends so they can actually track the mastitis status within their herd and introduce control measures. With daily testing, the presence of a single infected cow elevates the SCC level markedly above the base level. Farmers are able to respond within 1 day. They identify the animal concerned and carry out the appropriate control procedures. The overall com-

Figure 1: Farm bulk milk somatic cell count results, June 1996–May 1997.
company average SCC level has dropped 10% in the first season of per consignment testing. More importantly, the incidence of results over 400,000 cells per ml has decreased dramatically. This is seen in Figure 1. The best farmer in the company has a seasonal SCC average of 31,500 cells per ml.

During the 1996/1997 season a survey was conducted looking at 20 of the top performing herds. They were selected from herds who had an average SCC count below 75,000 cells per ml. Key findings were:

- Herd size ranged from 94 to 425 cows.
- Seven brands of milking machines were involved.
- Height and size of milking line did not seem to be a factor.
- 85% dry cow treated the entire herd.
- All were heat spraying.
- 80% were using iodine test sprays.
- Most had been following a plan for at least 3 years.
- Their main sources of information were the dairy company and their veterinarian.
- All farms showed excellent stockmanship.

The one conclusive piece of information was that you did not have to be perfect to achieve excellent results.

**BENEFITS**

The gains made by introducing per consignment SCC testing can be seen in a lowering of the overall company SCC average. There is also a dramatic reduction in the incidence of results over 400,000 cells per ml. More importantly, the major gain is in farmer attitudes. The philosophy of providing farmers with management information rather than simply test results has produced an interesting response. Farmers have now taken greater ownership of the quality performance on their farm. They are more in control and have learnt how to manage mastitis infections better on a day-to-day basis. Previously, with only three test results per month, they had a significantly lesser degree of control. With increased ownership of their quality performance we are seeing improvements in other quality parameters. We are significantly closer to our ultimate target of having effective quality management on farms.

R. Franks
New Zealand Dairy Group of Companies, Box 459, Hamilton, New Zealand
May 1997

### MILK QUALITY IN SPAIN

The national dairy herd in Spain consists of 1.28 million milking cows which makes up 6% of the total European Union (EU) dairy herd. Spain produces more than 6 million tonnes of milk which constitutes 6% of the total EU dairy production, ranking Spain in sixth place among the 15 EU country members. The mild weather of the Iberian Peninsula, especially in the north coast where more than 75% of the 100,000 dairy herds of Spain are located, is ideal for milk production. Moreover, the north coast of Spain is the region of the EU which economy depends more upon dairying because milk represents 40% of the gross agriculture production.

Since 1986 when Spain joined the EU, the dairy industry has gone through a profound transformation with a final positive balance. Milk yield has become steady and dairy farms have been modernized. In this period the national dairy herd and the number of farms have decreased by a third and a half, respectively. As a consequence of the abandonment plans promoted by the government and directed to small farms, the average size of a dairy herd has increased by three to five milking cows. Also, the average yield for cows under milk recording plans has increased to 7200 kg which ranks Spain in the top group of the EU. This increase has been due to a tremendous improvement in management, mainly in nutrition, genetic selection and mastitis control.

Measures to control mastitis and improve milk quality include courses for farmers, economic aids for the modernization of dairy farms including the milking parlour and refrigeration tanks, and implementation of programmes in dairy associations and cooperatives oriented to improve the hygienic quality of milk, including the incorporation of qualified personnel to advise and organize the programmes. On the other hand, the recently created Interprofessional Laboratories and the payment system based on composition and hygienic quality of milk have decisively impelled raw milk quality in such a way that today grade A milk must contain less than 100,000 cfu/ml and 400,000 cells/ml and should not contain inhibitors or added water. The penalties for farmers who do not reach the A grade may go up to 10 pesetas/litre.

However, in spite of the efforts during the last decade, the competitiveness of the dairy industry in Spain is being rationalized due to an insufficient milk production quota assigned by the EU to Spain which is inadequate for producers as well as for the industry and consumers, and produces a discompensation between production and consumption of more than 20%.

Previous to the incorporation of Spain in the EU, milk was mainly commercialized as liquid milk and consumption of dairy products was far less than in most other countries of the EU. This situation favoured the production over the composition of milk in the genetic selection programmes. However, after the incorporation of Spain in the EU there has been an increase in both production and consumption of cheese, fresh products, ice cream and low fat dairy products in such a way that the trend is to rank equally with our European neighbours. This, together with the need to compete in the international market has reoriented the genetic selection of dairy cows from the traditional objective of production (kg of milk) to a selection based on composition (kg of protein and fat). The actual average milk composition data in Spain is 3.7% fat and 3.07% protein.

The hygienic quality of milk delivered to the industry has improved substantially in the last decade. In 1995 the percentage of herds with bacteria count less than 100,000/ml was 45%, which represents a 12% improvement from 1985. Considering that usually the dairy herds with better hygienic quality are also the most producers, the percentage of milk produced in Spain that year under 100,000 bacteria/ml was probably 10-20% higher than 45%. More recent data from an Interprofessional Laboratory on the north coast, which is representative of the largest producing region of Spain, reveals that 79% of farms delivering more than 100,000 litres/year have milk with less than 100,000 bacteria/ml.

The improvement in milk hygienic quality, although with small differences, occurs in most milk producing regions of Spain. Reports from two other regions of Spain that have followed intensive quality control programmes for years show that 80% of the farms and 90% of the milk produced contain less than 100,000 bacteria/ml.

In 1995 the percentage of farms with milk somatic cell counts lower than 400,000 cells/ml was approximately 51%. However, similar to bacteria counts, the percentage of milk produced under this category would be underestimated. Recent data from the above mentioned Interprofessional Laboratory revealed that milk from 74% of the farms producing more than 100,000 litres/year contain less than 400,000 cells/ml. Most other regions
are also experimenting improvements in milk somatic cell counts. In another region with a milk quality programme implemented for the last 15 years, 77\% of the farms produce milk under 400,000 cells/ml and consequently 90\% of milk would be under the European directive.

With respect to the etiology of mastitis, two recent studies in our lab analysing milk bulk tank samples from more than 1000 farms revealed a 61\% prevalence of Staphylococcus aureus, 8.7\% prevalence of Streptococcus agalactiae and less than 1\% prevalence of Mycoplasma bovis. Studies analysing individual samples reveal that St. aureus is the predominant major pathogen (17\%–25\%) followed by Str. agalactiae (5\%–8.5\%), Streptococcus uberis (5\%–6.3\%), Escherichia coli and Streptococcus dysgalactiae (1.5–2\%) and Actinomyces pyogenes (1.2\%). Among minor pathogens C. bovis is the most prevalent (7.5–10\%), followed by coagulase negative staphylococci (5–8\%).

Finally, efforts for the eradication of zoonosis in Spain during the past 20 years are reflected in the low prevalence levels of brucellosis and tuberculosis observed. 99.4\% and 98.6\% of cows are free from brucellosis and tuberculosis, respectively.

Although not having yet the official data from the last campaign, looking at the trend in milk quality improvement during the previous years and at the increasing mentalization of farmers towards the production of quality milk, as well as at the continuous decrease in small farms promoted by the national government and by the EU, it is expected that in January 1998 most milk produced in Spain will be under the European directive.

E. Cifrian\(^1\), J.A. Garcia\(^2\), P.Y. Casado\(^3\) & J.C. Marco\(^1\)

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\(^3\) Universidad de Cantabria, Spain

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**Switzerland**

Evolution of Somatic Cell Counts in Bulk Milk Samples: Switzerland 1983–1996

![Graph showing evolution of somatic cell counts](image)

### Distribution of samples

<table>
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<th>Percent of Samples</th>
<th>SCC Range (thousand cells/ml)</th>
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<td>≥1000</td>
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</tbody>
</table>

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*Schällibaum*

Milk Production and Hygiene Section, Federal Dairy Research Institute, Liebefeld, CH-3003 Bern, Switzerland
Events & Meetings

REPORT OF THE SEMINAR “A HALF CENTENARY OF LACTATION BIOLOGY RESEARCH”
UNIVERSITY OF GENT, BELGIUM, 20–22 NOVEMBER 1996

At the occasion of 50 years mammary gland biology research at the Milk Secretion and Mastitis Research Center of the Department of Physiology, Biochemistry and Biometrics of the Faculty of Veterinary Medicine of the University of Gent, and at the National Institute for Agricultural Research (INRA) in France, a seminar on “A half Centenary of Lactation Biology Research” was organized on 20–22 November 1996 at the University of Gent. The organization was in the hands of the Milk Secretion and Mastitis Research Center of the Department of Physiology, Biochemistry and Biometrics, with financial support from the European Union and the industry.

The venue of this congress was the old Dominicans Monastery “Het Pand”, which is now one of the most beautiful congress venues of the University of Gent, and the new campus of the Faculty of Veterinary Medicine. Only invited speakers presented their lectures, with no possibility for free oral or poster presentations. As a consequence, outstanding contributions were presented by world famous specialists in this field of research. These interesting communications gave rise to fruitful discussions that resulted in new ideas for future research.

The scientific part of this seminar consisted of four sessions. In the first session, an overview of 50 years of lactation and mastitis research was presented by specialists from Scandinavia, Israel, the United Kingdom, New Zealand, Italy, Germany, the USA and France. Some topics were mastitis control, the use of antinflammatory drugs in mastitis therapy, defence mechanisms of the mammary gland, milk quality and milk quantity as regulatory elements for mastitis research, vaccination against mastitis, and finally some overviews of mastitis research during the last 50 years in some countries. On the second day, the first session was continued with specialists from Japan, Spain, Belgium and the Netherlands who talked about the evolution of the milk somatic cell count and about the immunity of the mammary gland.

In the second session, some models to study mastitis were presented. The results from the research of some Ph.D.-students of the organizing department were subject to the critical sense of a great number of auditors. The presentations on phagocytosis and detoxification of endotoxins during E. coli mastitis, on diapedesis in an in vitro cell culture model of a bovine mammary gland, and on the respiratory burst activity during the early postpartum period and effects of drugs, metabolites and hormones on this burst activity, gave rise to interesting and fruitful discussions in the audience. On the last day, the third session studied the physiology and immunology of the mammary gland of the teats and the secretion of milk components such as proteins, in milk.

With the BSE affair freshly in mind and under the impetus of the European Union, the last session was devoted to Virotits and Prion Diseases in ruminants. In this session attention was paid to the infection of the mammary gland of small ruminants with lentiviruses, to the pathogenesis of Visna-Maedi in the mammary gland in sheep, to the pathogenesis of scrapie, and finally to the ethiology, diagnosis and epidemiology of BSE in cattle and other species.

Besides the scientific part, an extensive social programme was organized, with visits of exhibitions, the city of Gent, and to an exhibition of 700 Years of Augustinians. The seminar was closed with a reception at the library “Bibliotheek Wittockiana” in Brussels on the occasion of the opening of an exhibition on 11 generations of Japanese printing on a log of wood, and with a closing dinner in the centre of the capital of Europe, Brussels.

Relying on the reactions of the participants during and after the seminar, this celebration congress may be considered as a real success, and we were very happy to meet Prof. Dr em. Georges Peeleers, who is the founder of the lactation biology and mastitis research at the Faculty of Veterinary Medicine of the University of Gent, every day on this seminar as an interested and critical auditor.

A book of abstracts of this seminar has been edited ("Commemoration of A half Centenary of Lactation Biology Research"), Edited by C. Burvenich and D. Hoeben, Gent; ISBN 90-802791-2-9, and will appear on our Web-site (http://mpps.rug.ac.be). During 1997, the papers presented at this congress will be published in a book as a special issue of the "Flemish Veterinary Journal".

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THE FUTURE USE OF ANTIBIOTICS IN MASTITIS THERAPY: A REPORT FROM A NORDIC SEMINAR IN JANUARY 1997

The issue of how antibiotics are used in animal production is of urgent interest due to the large amount of reports on increased bacterial resistance to antibiotic drugs from all over the world. The resistance problems interfere profoundly with the therapy outcome in treatment of humans as well as animals with infectious diseases. In January 1997 a seminar was held in Gothenburg, Sweden, to discuss this subject in relation to mastitis therapy. The seminar, with the title "The future use of antibiotics in mastitis therapy", was arranged by NMSM (The Nordic Dairy Associations' Committee for Milk Quality).

The invitation had attracted 170 participants from eight European countries, and several faculties of veterinary medicine, practitioners, farmers, dairy companies, microbial laboratories and drug companies were represented. The oral presentations focused on the following subjects.

Raw milk quality – Demands from the consumers, the authorities and the dairy industry
- Residues in milk. Testing routines in the Nordic countries in relation to the EU directives. Åse Stermešjö, Ph.D., Swedish University of Agricultural Sciences.

Current status of the antibiotic resistance situation and spreading of resistance mechanisms
- Development of resistance, risks for various animal species. Henning Særum, D.V.M., Ph.D., Norwegian College of Veterinary Medicine.
- Resistance of human pathogens and connection with animal production. Pentti Huovinen, Physician in chief, National Public Health Institute, Finland.
- International comparisons of drug handling principles
- International drug handling policies. Withdrawal periods for antibiotics used in treatment of mastitis in cows in the Nordic countries. Folke Rasmussen, Professor, D.V.M., D.V.Sc., Denmark.
- General principles for mastitis therapy in the Nordic countries. Hans Jørgen Andersen, D.V.M., Danish Dairy Board.
- Survey of the use of antimicrobial drugs in veterinary medicine in Sweden and Norway with special emphasis on mastitis treatment. Lolita Nilsson, D.V.M., Swedish Veterinary Institute, and Kari Grave, Ph.D., Norwegian College of Veterinary Medicine.

Current antibiotic and homeopathic principles for treatment of clinical mastitis
- Recommended principles for treatment of mastitis caused by Gram negatives (all coliforms). Jørgen Katholm, Veterinary Practitioner, Denmark.
- Alternatives to traditional mastitis therapy. Mette Vaarst, D.V.M. Ph.D., Danish Institute of Animal Science.

The farmers' view on current mastitis therapy

The seminar resulted in many interesting discussions and conclusions. It became obvious to the audience that resistance mechanisms emerge from well preserved microbial resistance genes. The substances have most probably been used by certain microbial strains to keep up its own population. A common reservoir of antibiotic resistance genes, shared by bacteria from different ecological niches, seem to exist. The extensive use of antibiotic drugs has resulted in a world-wide soaring antibiotic resistance both in human medicine and in animal production due to the “leaking” of resistance genes across very heterogenic ecological systems.

Mastitis is by far the main diagnosis leading to the prescription of antibiotics to dairy cows. Therefore, the principles must continuously be discussed and evaluated.

The meeting agreed on several matters, amongst which four main points could be mentioned.

- Antibiotic use must decrease in order to preserve its future usefulness. To achieve this goal the diagnostic tools and prescription practices have to be continuously supervised.
- The Nordic countries share a common view on the need of reducing the use of antibiotics in the dairy production. A much more pronounced selectivity must be achieved as to which cases should be treated with antibiotics. Moreover, the drug chosen for treatment should be directed towards the actual microorganism. Thus, broad spectrum preparations should be avoided. In the Nordic countries the majority of cases should be treated with pure penicillin.
- Alterations in the treatment pattern are slow and are controlled by the local practitioners. A considerable acceleration of the process is however achieved if economic measurements are introduced.
- There are large reproducible differences between herds in the amount of antibiotics used. Efforts should therefore be concentrated on prophylactic measures and on research projects identifying risk factors for clinical mastitis.

A seminar on the principles of mastitis prophylactics in dairy herds is planned to be held in 1998. Presumably, the work will result in common Nordic principles for mastitis therapy.

Reference

Documentation from the seminar can be ordered from the Swedish Association for Livestock Breeding and Production (SHS), Britt Grandin, S-631 84 Eskilstuna, Sweden, at the cost of:
SEK 350.— (complete documentation)
SEK 30.— (individual papers)

Ch. Hallén Sandgren
Research and Development, Swedish Association for Livestock Breeding and Production, S-631 84 Eskilstuna, Sweden
US NATIONAL MASTITIS COUNCIL ANNUAL MEETING – 1997

Nearly 450 people convened in Albuquerque, New Mexico, to attend the 36th NMC Annual Meeting held 16–19 February. The 4-day conference included committee meetings, short courses, a poster session, and general sessions. The meeting also featured a special seminar, "Milk Production: Hazards and Risks from Microbial Pathogens and Chemical Residues" on Sunday afternoon which was held jointly with the IDF A2 Group of Mastitis Experts. Topics covered in the seminar included, "Quality Milk Production – Potential Hazards, Critical Control Points, and the Application of Risk Analysis" by Prof. W. Heeschen (DE); "FDA Concerns with Pathogens and Chemical Contaminants in Raw Milk" by Dr. J. Smucker (US); "Mastitis and Dairy Environment Pathogens of Public Health Concern" by Dr. J. Cullor (US); "Milk as a Risk Factor for BSE" by Dr. E. Hileman (UK); "Raw Milk Cheese and Human Health Concerns" by Dr. A. Zecconi (IT); and "Milk as a Risk Factor for Crohn's Disease" by Dr. G. Mechor (US). All papers are available in the Proceedings 36th Annual Meeting.

International participation in NMC continues to increase, as evidenced by the 78 individuals from 15 countries outside the US who registered for the meeting. This was the first Annual Meeting to feature simultaneous translation to Spanish. The international scope of the organization and its close ties to IDF Group A2 were also evidenced by the fact that the key note speaker for the opening session was Dr. Murray Woolford, Dairy Research Corporation, Ruakura Research Station, Hamilton, New Zealand. Dr. Woolford is the New Zealand delegate to Group A2. His presentation was titled, "Perspectives on Mastitis From Down Under".

Topics for the five General Sessions were: (1) Improving Milker and Machine Performance; (2) Managing Udder Health Data; (3) Biosecurity for Herd Udder Health; (4) Mastitis Research Briefs; and (5) Residue Avoidance in Assuring Quality Milk. In addition to the General Sessions there was a Poster Session with 33 posters. Manuscripts for all papers and posters presented are in the Proceedings 36th Annual Meeting.

Each year a new Board of Directors, Executive Committee and Officers are elected at the annual meeting. The Board is comprised of 48 members elected to serve 3-year terms, with a maximum of two consecutive 3-year terms allowed. About one-third of the Board is elected each year. The Board is selected to represent all member interests. The Executive Committee consists of 15 members elected by and from the Board of Directors to serve 1-year terms. The Officers also serve 1-year terms. The President alternates annually between industry and academic representatives.

As a result of bylaw changes implemented last year, the NMC has a new officers position: Second Vice President. Previously, the officers included President Vice President, Secretary and Treasurer. To help provide an additional "break-in" period for the President, and to provide for more continuity, a Second Vice President position was added. After serving for 1 year, the Second Vice President moves into the First Vice President position, while the First Vice President moves into the Presidency. The First Vice President serves as Program Chair, and the Second Vice President acts as the Short Course Chairperson.

This year's First Vice President is Bob Harmon, Professor of Animal Science & Director o' Graduate Studies, University of Kentucky. Jim Dickrell, Editor, Dairy Today, was elected Second Vice President. Allen O'Hara, Maryland and Virginia Milk Producers, Reston, Virginia, was re-elected Secretary, and shall serve as acting-Treasurer for 1997.

Dr. Keith Sterner, veterinarian from Ionia, Michigan, was elected NMC President for 1997–1998. Dr. Sterner, Vice President and Program Chair this past year, succeeds Dr. K. Larry Smith, researcher at the Ohio Agricultural Research and Development Center, Ohio State University, Wooster, Ohio.

The NMC 37th Annual Meeting will be held in conjunction with the American Society of Agricultural Engineers, International Dairy Housing Conference, 26–30 January 1998 at the Adam's Mark Hotel in St. Louis, Missouri. The NMC meeting will take place from Sunday to Wednesday (26–28 January), followed by the Dairy Housing Conference from Wednesday to Friday (28–30 January). A joint session will be held Wednesday. Keynote speaker is Dr K. Lerry Smith and the title of the talk is "Milk Quality – A Worldwide Perspective". Additional sessions will discuss the topics of "Milk Quality – Can we Compete Globally".

"Pathogen Interactions with the Teat End", "Opportunities and Challenges in Expansion", "Robotics and Automation", and "On-farm Monitoring and Management".

The 1998 NMC Regional Meeting (Summer meeting) is tentatively scheduled for Seattle, Washington. Another meeting in the planning stages is an International Mastitis Seminar to be jointly sponsored by NMC and the American Association of Bovine Practitioners. Tentative plans are to hold the seminar in September 2001 in Vancouver, Canada.

The NMC home page is up and running at <http://www.nmcromiseonline.org>. The home page includes basic information about NMC (what NMC is, how to join, etc.), on-line information dealing with mastitis and milk quality, a list of NMC available publications, meeting announcements as well as links to other mastitis resources on the web. In addition to the web, NMC can be contacted by writing to NMC, 2820 Walton Commons West, Suite 131, Madison, WI 53718-6797 (phone 1-608-224-0622; fax 1-608-224-0644; e-mail <nmc@requestllc.com>). Membership is $50 US for individuals outside the North American continent and includes the Proceedings of both the Annual Meeting and the Summer Meeting. Udder Topics (the NMC newsletter published every 2 months) and a variety of fact sheets on mastitis control. New publications available include a video on "Vacuum Levels and Air Flow in Milking Systems". In addition a revision of "The Laboratory and Field Handbook" is currently being completed and should be available in early 1998.

Prof. K. Larry Smith
The Ohio Agricultural Research and Development Center, 1680 Madison Ave., Wooster, Ohio 44691, USA

A. Saeman
National Mastitis Council, 2820 Walton Commons West, Suite 131, Madison, Wisconsin 53704, USA
The first session was entitled "BASIC ELEMENTS AND TRENDS IN MASTITIS PREVENTION" (Chairman: W. Heeschen, Kiel).

This opening session was introduced by a keynote address "Strategy of mastitis control", by J. Hamann, Hannover. The following four papers included a discussion of the importance of machine milking as a predisposing factor for mastitis, the efficacy of post-milking teat disinfection and the interaction between feeding regimes and the new infection risk.

Session two had the topic "HERD RELATED MASTITIS DIAGNOSTICS" (Chairman: K.-H. Lotthammer, Oldenburg)

The introductory paper "Clinical and laboratory mastitis diagnosis" was given by M. Hoedemaker, Hannover. The following three papers included the description of strategies used by the animal health service institutions in the field of mastitis control. The results presented indicate the need for herd specific mastitis control measures.

Session three was "MASTITIS THERAPY: PHARMACOLOGY, ANTIBIOTIC RESISTANCE AND RESIDUE PROBLEMS" (Chairman: W. Gedek, Grub).

This session was opened by M. Kietzmann, Leipzig, with the presentation: "Pharmacological fundamentals of mastitis therapy". The paper demonstrated clearly the need to include pharmacokinetic parameters in the selection of the most suitable antibiotic depending on the application route. Three other papers discussed aspects of antibiotic resistance and of residue problems.

The last session covered the topic "POSSIBILITIES AND LIMITATIONS OF MASTITIS THERAPY AS ELEMENT OF MASTITIS CONTROL" (Chairman: J. Hamann, Hannover). The first presentation was given by K. Wendt, Berlin: "Efficacy of therapy during lactation and dry period". This paper and three other presentations stressed the importance of the antibiotic therapy as a fundamental part of an integrated mastitis control strategy.

The proceedings of this conference (in German language) are available from: "Deutsche Veterinärmedizinische Gesellschaft (DVG), Frankfurter Str. 89, D-35592, FRG".

Prof. Dr J. Hamann
Dept. Hygiene and Technology of Milk, Veterinary School Hannover, Bischofsholer Damm 15, D-30173 Hannover, Germany
IDF Publications on Mastitis

All documents listed below can be obtained from IDF Brussels as per address on cover: prices are shown in Belgian Francs.

**RECOMMENDATIONS FOR PRESENTATION OF MASTITIS-RELATED DATA**

Part 1: Somatic Cell Count
Part 2: Records of Clinical Mastitis
by a sub-group of IDF Group A2 – Bovine Mastitis

Historically, somatic cell count data have been presented in a variety of ways, making comparisons of data from different sources difficult. If not impossible. Milk somatic cell counts are increasingly used to compare milk quality within regions or states of a country as well as among countries. The final number used to indicate the status of a country region/milk cooperative can vary greatly depending upon the method used for calculation. As the demand for such comparisons increases, so does the need for a standardized method of calculation. A sub-group of A2 was organized under the leadership of Olav Østerås (Norway) with the charge to produce a document recommending standardized methods for presentation of somatic cell count data. A section on presentation of clinical mastitis data is included as these data also suffer from a lack of consistent method of presentation, and comparisons among studies or reports are very difficult.

The document is presented in the form of a condensed version for quick reading and introduction to the subject matter, and as the full text with complete detail. The document will be a useful reference for those publishing data involving somatic cell counts and/or incidence of clinical mastitis cases, and will help bring clarity to an area where it is needed.

**GUIDELINES FOR EVALUATION OF THE MILKING PROCESS**

by J. Hamann (Germany) (in conjunction with the IDF Machine Milking and Mastitis Subgroup A2D of Group A2)

The paper describes guidelines to evaluate the entire process of mechanical milking. Application of the guidelines will result in detailed information on interactions between machine, milker and dairy cows, and the related efficiency of milking, milk removal and any risk of new infection of the mammary gland. The guidelines are based mainly on evaluation of the following criteria: (1) Operator action and behaviour; (2) Animal factors and behaviour; (3) Machine characteristics, and (4) General conditions of housing and management.

**Bulletin N°321/1997** – 1200 BEF

**MASTITIS CONTROL (RESULTS OF QUESTIONNAIRE 1694/A)**

by IDF Group of Experts A2 – Bovine mastitis

The replies of 24 member countries to IDF mastitis control questionnaire 1694/A issued in February 1994 are tabulated. The survey shows a high degree of uniformity in recommended mastitis control measures and an increase in their application on-farm since the previous questionnaire 5 years before. There is little evidence of a reduction in infection levels, although cell counts are lower and there has been a big increase in cell count payment schemes in the countries replying to the questionnaire.

**Bulletin N°305/1995** – 1400 BEF

**TEAT TISSUE REACTIONS TO MACHINE MILKING AND NEW INFECTION RISK**

Document prepared by the IDF Machine Milking and Mastitis Subgroup A2D working under the chairmanship of Prof. Dr. J. Hamann (Germany)

A description of the physiological status of the teat is used as a reference for the evaluation of the teat tissue reactions induced by machine milking and their impact on the new infection risk.

**Bulletin N°297/1994** – 1300 BEF

**MASTITIS CONTROL**

by a Group of Experts

Results of Questionnaire 1889/A of 16 pages with results from 23 countries: data for cow population, mastitis control schemes, monitoring procedures, antibiotic sensitivity, mastitis control measures, milk payment, progress in mastitis control.

It is part of a three-part Bulletin which also covers payment systems for ex-farm milk and the alkaline phosphate test as a measure of correct pasteurization.

**Bulletin N°252/1991** – 1400 BEF

**DESIGN OF CLINICAL TRIALS FOR MASTITIS THERAPY**

by Margaret A. Thorburn, Dept. of Population Medicine, Ontario Veterinary College

This 8-page report covers clinical trials of therapeutic treatments; causes of mastitis and its consequences.

It is part of a five-part bulletin which also covers: radioclines in dairy products; distribution systems for fresh dairy products; enzymes in cheesemaking; and teat & udder cleaning.

**Bulletin N°247/1990** – 1500 BEF

**ENVIRONMENTAL INFLUENCES ON BOVINE MASTITIS**

by a Group of Experts

Covers mastitis as a multifactorial disease, pathogenesis, sources & transmission of pathogens, environmental influences on animal health, external environment, internal environment, conclusions and recommendations.

**Bulletin N°217/1987** – 1000 BEF

**MACHINE MILKING & MASTITIS**

by a Group of Experts

Comprises a) recommendations concerning the use of milking machines and the incidence of mastitis; b) review of literature on milking machine factors affecting the rate of new infections; c) review on the effect of machine milking on teat end condition.

**Bulletin N°215/1987** – 1000 BEF
BOVINE MASTITIS: DEFINITION & GUIDELINES FOR DIAGNOSIS
by a Group of Experts

This bulletin gives new (compared to 1967) proposals for mastitis definitions, diagnosis & the results of an IDF trial on the interpretation of diagnostic data.

Bulletin N°211/1987 - 800 BEF

PROGRESS IN MASTITIS CONTROL
by a Group of Experts

This survey describes in tabular form the progress made in 23 countries, on the basis of an enquiry conducted in September 1993. In a previous survey, of 1977 (see Bulletin 121), many countries reported little progress; this time, 7 countries reported definite improvement to 1983.

Bulletin N°187/1985 - 500 BEF

MASTITIS RESEARCH INDEX
(13TH EDITION, 1996)
MASTITIS RESEARCH INDEX AVAILABLE IN INTERNET

The 13th edition of MRI was published in January 1996. It includes 271 mastitis research projects from 71 laboratories in 28 countries.

The printed version is available from the IDF office (Square Vergote 41, B-1050 Brussels, Belgium, fax +32 2 733 04 13, e-mail: fil-idf@email.interpac.be).

The index is also available in Internet. If you have access to WWW, use address http://www.helsinki.fi/~hsalonen/. By file transport protocol you can find it at ftp.funet.fi/pub/sci/medicine/vetmed/MRI96.zip. The same file is also available as MRI96.txt text file.

The next printed edition of MRI will be published in 1998. Before that the electronic form of the index will be updated, if mastitis laboratories give new research topics. Send the information to the editor by mail, fax or e-mail.

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MASTITIS NEWSLETTER N°21
GENERAL
Report of the IDF Group of Experts on Mastitis - K.L. Smith, Chairman (USA)
Integrated Detection Systems for Antimicrobial in Milk: The IDF Approach - W.H. Heeschen (Germany)

RESEARCH COMMUNICATIONS
Standards for Somatic Cells in Milk: Physiological and Regulatory - K.L. Smith (USA)
Somatic Cells: Factors of Influence and Practical Measures to Keep a Physiological Level - J. Hamann (Germany)
Somatic Cells and their Significance for Milk Processing (Technology) - A. Zeconci (Italy)
Milk Quality Payment: Quality Assurance (QA) in Somatic Cell Counting - M. Schällbaurn (Switzerland)
Mastitis: The Disease under Aspects of Milk Quality and Hygiene - W.H. Heeschen (Germany)
Now Systems for Somatic Cell Counts - J. Reichmuth (Germany)

MASTITIS NOTES FROM MEMBER COUNTRIES
Finland: Mastitis Prevention has Succeeded in Finland - T. Honkanen-Buzalski & V. Myllyss
Italy: Mastitis Control Programme and Breeders Association - A. Zeconci & M. Noceti
Norway: Bulk Milk Somatic Cell Count in Goat Milk (A presentation according to new standard) - O. Østeras & T. Lunder

Sweden, Norway, Denmark & Finland: Antimicrobial Drug Policy in Four Nordic Countries - K. Plym Forshell, O. Østeras, K. Aagaard & L. Kukkas
Ireland and USA: Analysis of diversity of Staphylococcus aureus isolates from bovine mastitis using DNA restriction fragment length polymorphisms of rRNA genes - J.R. Fitzgerald, C.J. Smyth, P.J. Hartigan, W.J. Meaney & V. Kapur
Switzerland: Mastitis Pathogens in Switzerland 1588-1994 - M. Schällbaurn

EVENTS & MEETINGS
British Mastitis Conference

IDF PUBLICATIONS ON MASTITIS
Ref. N°144 – Available on request – September 1996

MASTITIS NEWSLETTER N°20
GENERAL
- Report of the IDF Group of Experts on Mastitis - J.M. Booth (United Kingdom)
- Hygienic Requirements in International Trade and the Role of Codex Alimentarius and the International Dairy Federation - W.H. Heeschen (Germany)

RESEARCH COMMUNICATIONS
- Treatment of Mastitis with Homoeopathic Remedies - W.J. Meaney (Ireland)
- Mastitis Cell Count Data - J.M. Booth (United Kingdom)
- Counting Somatic Cells in Milk: Reference Material ("Kiel Standards") - W.H. Heeschen & E.-H. Ubben (Germany)
- The Importance of Coagulase-Negative Staphylococci - K.L. Smith & J.S. Hogan (USA)
- Somatic Cell Counts in Milk of Goats - B. Poutrel (France)

MASTITIS NOTES FROM MEMBER COUNTRIES
Finland: The Bovine Udder and Mastitis - M. Sandhol, T. Honkanen-Buzalski, L. Kaartinen & S. Pyörälä (Editors)
Germany: New German Guidelines for Mastitis Control - J. Hamann
Switzerland: Mastitis Pathogens 1988 - 1993 - M. Schällbaurn

EVENTS & MEETINGS
- The 3rd International Mastitis Seminar
- British Mastitis Conference
- Symposium "Udder Health" in the Netherlands

IDF PUBLICATIONS ON MASTITIS
Ref. N°142 – September 1995 – 500 BEF
MASTITIS NEWSLETTER N°19
Report of the IDF Group of Experts on Mastitis -- J.M. Booth (United Kingdom)

RESEARCH COMMUNICATIONS
- Counting somatic cells in milk: results of IDF intercomparison trials -- W.H. Heeschen (Germany)
- Studies on inflammation in the bovine teat with regard to its role in the defence against udder infections -- K. Persson (Sweden)
- Cubicle designs for dairy cattle -- J. O'Connell & B. Meaney (Ireland)
- Retarded excretion of antibiotics in milk after drying-off therapy -- M. Schällbaum (Switzerland)

MASTITIS NOTES FROM MEMBER COUNTRIES
- Czechoslovakia: Standardization in somatic cell counting -- D. Rysánek, V. Babák & L. Siehöferová (Czech Republic)
- Finland: The status of mastitis in the Nordic countries -- S. Pyörälä & T. Honkanen-Buzelisik (Finland)
- Israel: The national program for the control of mastitis and the improvement in milk quality -- A. Saran (Israel)
- Italy: Eradication and control programs -- A. Zeconi & G. Vicenzi (Italy)
- New Zealand: SAMM -- A new mastitis control plan -- M.W. Woolford (New Zealand)
- Norway: Norwegian cow milk somatic cell count -- O. Østérås (Norway)
- Switzerland: Mastitis pathogens 1988-1992 -- M. Schällbaum (Switzerland)

EVENTS & MEETINGS

IDF PUBLICATIONS ON MASTITIS
Ref. N°140 -- Available on request -- August/Août 1994

MASTITIS NEWSLETTER N°18
- Annual report of the IDF Group of Experts on Mastitis (1992) (J.M. Booth, Chairman, UK)
- Mastitis cell count data (J.M. Booth, Chairman, UK)
- Somatic cells in milk - aspects of quality, hygiene & mastitis control (Prof. Dr W.H. Heeschen, Germany)
- Homoeopathic treatment of bovine mastitis (J. Hamann, Germany)
- Cell count interpretation (D.P. Ryan, Australia)

RESEARCH COMMUNICATIONS
- A strategy to increase resistance in dairy cows: expression of human lactoferrin in the milk of transgenic cows (J.H. Nuijens, M. Geerts, R. Strijker, F. Pieper & H.A. de Boer, the Netherlands)
- Systemic dry cow therapy - an update (Dr A. Saran, Dr G. Ziv & Dr S. Soback, Israel)

MASTITIS NOTES FROM MEMBER COUNTRIES
- the prevention of mastitis in Italy (G. Ruffo & A. Zeconi, Italy)
- Mastitis pathogens in Switzerland, 1988-1991 (Prof. Dr M. Schällbaum, Switzerland)

EVENTS & MEETINGS

IDF PUBLICATIONS ON MASTITIS.
Ref. N°134 -- Available on request -- April/Avril 1993

MASTITIS NEWSLETTER N°17
Antibiotics and sulfonamides in milk - risk evaluation of residues (Prof. W.H. Heeschen, Germany). Teat dipping before milking - summary of UK field trials (S.A. Langridge, UK). What future for conductivity? (A. Zeconi, Italy), Mastitis pathogens in Switzerland (M. Schällbaum, Switzerland), Mastitis events, Mastitis publications.

MASTITIS NEWSLETTER N°16
Somatic cell counting, individual cow somatic cell counts, mastitis cell count data, efficacy of on-line measurement of quarter electrical conductivity, mastitis notes from Iceland, Japan, Norway, Switzerland, mastitis events, IDF and other mastitis publications.

MASTITIS NEWSLETTER N°15
EEC Cell count requirements - Use of cowside tests for mastitis - Research Communications - Some reflections on application of DNA probes in mastitis diagnosis - Predipping in perspective - Mastitis notes from member countries.
Ref. N°112 -- Available on request -- May 1990

MASTITIS NEWSLETTER N°14
Cell count standard - Mastitis cell count data - Future EEC cell count requirements - New information relates diets of dairy cows to mastitis.
Ref. N°106 -- March 1989

MASTITIS NEWSLETTER N°13
Questionnaire on national herd milk mastitis cell counts - Mastitis notes from member countries.
March 1988 - Ref. N°102

MILK - ENUMERATION OF SOMATIC CELLS
Standard/Norme 148A:1995 - 500 BEF

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Bulletin of the IDF 330
FOR A SUSTAINABLE DEVELOPMENT IN DAIRYING

Boehringer Ingelheim