MASTITIS EPIDEMIOLOGY
PRACTICAL APPROACHES AND APPLICATIONS

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1. INTRODUCTION

Mastitis is defined as an inflammation of the udder. The International Dairy Federation (1999) has recommended definitions and further classification into severe, moderate or mild clinical mastitis (CM) and subclinical mastitis. Severe and moderate CM usually need antibiotic therapy and should be treated in the interests of animal welfare. Therapy decisions for mild CM and subclinical mastitis should be based more on economic evaluation.

Clinical mastitis is by far the most common and most costly disease in milk production in the industrialized countries. Indicators of subclinical mastitis can be bulk milk somatic cell counts (BMSCC) at the national level and cow/composite milk SCC or CMSCC at the individual cow level. Costs are related to loss in milk quality, decreased milk production related to subclinical mastitis, discarded milk and replacement cows, cost of antibiotics and labor costs (International Dairy Federation, 2005). In Norway this loss is estimated to have cost approximately 190 million NOK (approximately 23.5 million €) in a population of 270,000 dairy cows, or 0.13 NOK (€ 0.016) per liter of milk produced in 2003 and 2004. The loss corresponds to 4% of the market value of milk at farm level.

Various definitions of epidemiology are presented in different textbooks. Houe et al. (2003) translate epidemiology literally as the study (logos) of what is upon (epi) the population (demos). Epidemiology has traditionally been defined as the study of occurrence and distribution of diseases in populations as well as the study of factors that influence disease occurrence. Kleinbaum et al. (1982) pointed out three different important issues within epidemiology. Issue 1 is the choice of underlying measure of disease frequency. Issue 2 is the extent to which the results obtained from the study may be distorted because of some biasing aspect in the design and/or analysis of the study. This issue affects the validity of the study. Issue 3 is the need to take into account extraneous factors (and control them). These are factors other than the exposure to disease and the disease variables. Thus the general aims of epidemiology are:

- to describe the health status in the population,
to explain the etiology of disease by determining factors that “cause” the specific disease,

to predict the number of disease incidents and the distribution of health status within populations and,

to control the distribution of disease in the population by prevention of new occurrences, eradication of existing cases and otherwise improving the health status.

Dohoo et al. (2003) mention as important that epidemiologists strive to identify exposures and evaluate their associations with various outcomes of interest (e.g. health, welfare, productivity) so as to improve the lives of animals and their keepers. From this definition we also see that animal welfare and economics (through productivity) are included in “epidemiology”.

As the title of this lecture is “practical approaches and applications” I will point out some practical important issues in using mastitis epidemiology to move towards improvements in description and measurement of the disease as well as critical points for success with a control program adapted to time and place.

2. MEASURING THE DISEASE

The first key in epidemiology is to measure disease. This seems obvious but it is not very easy. The importance of measuring disease and a number of pitfalls are identified in the IDF document (IDF, 1997). This document points out for example, that simply using different calculation techniques can cause at least a 30% difference in disease measurements.

3. MEASUREMENT OF SUBCLINICAL MASTITIS (USING SCC)

Subclinical mastitis is mostly measured routinely by use of somatic cell counts (SCC). This is usually done at herd level as bulk milk somatic cell count (BMSCC) by sampling the bulk milk regularly. This parameter is most important as a measure of milk quality and is used as a baseline for milk quality payment to determine either premium payments or discounts. At cow level, cow or composite milk somatic cell count (CMSCC) is measured either monthly or every second month as a routine in animal recording systems at the same time as the content of fat, protein, lactose and other parameters are measured. CMSCC is extensively used as a management tool at herd and cow level or as a breeding tool to select bulls for mastitis resistance. Quarter milk somatic cell count (QMSCC) is occasionally used as a measure of inflammation at quarter level for research purposes.

Using SCC it is very important to define and be aware of the level you are working at, quarter, cow or herd. Different problems are associated with each level of use and one should be aware of them. In general SCC comprises lognormal distributed data and statistics such as mean and standard deviation should not be undertaken before transformation of the data, as pointed out in several of the reports summarized in the IDF document (IDF, 1997).
Figure 1. **Distribution of CMSCC in Norway during 2004**
As an example all CMSCC in Norway during 2004 (n = 1,239,250) had an arithmetic mean of 167,000/ml, a STD = 430,000 and a mode = 20,000. The median is 60,000/ml. The quartiles were Q1 = 30,000 and Q2 = 150,000. Five percent of the CMSCC were above 350,000. This is clearly demonstrated by the skewed distribution in Figure 1.

When transforming the CMSCC to the logarithmic scale the arithmetic mean of the natural logarithm is 4.23 (corresponding to 68,800/ml), STD = 1.21. This means that the confidence interval is 4.23 ± 1.96*1.21 which equals 6,400 to 736,000 SCC/ml. The distribution of lnCMSCC is presented in Figure 2.

Weighting the CMSCC by milk yield the CMSCC would be 161,000/ml. Without any discarding of milk from treated clinical cases or separating high CMSCC milk from delivery to the dairy processor the BMSCC is expected to be 161,000/ml at national level. However, the mean national level of BMSCC in Norway was 140,000 the same year (2004) and presented in Figure 3.
Figure 2. Distribution of LnCMSCC in Norway during 2004

Figure 3. The BMSCC in Norway during the period from 1980 to 2005

This difference of 21,000 could be mainly explained by the practice of separating milk with higher SCC, at cow level, from the delivery into the bulk tank due to therapy, or by management using CMSCC information to determine what milk to keep separate from the bulk milk. This also illustrates that care should taken when using BMSCC to describe udder health at herd level. It is now a better measure of herd quality management. Before the introduction of premium quality milk involving sorting milk according to quality, BMSCC was seen as an indicator of udder health. This is shown if one subtracts all CMSCC above 1 million: the remaining weighted means would be only 114,000. A figure of 142,000 could be reached by taking away all counts above 3 million, which
would be almost all clinical cases. If all CMSCC above 400,000 are removed from the production BMSCC would be as low as 83,000!! These arithmetical manipulations demonstrate that managing high BMSCC is just a question of management of high CMSCC and is less and less perceived as having an association with real subclinical mastitis.

QMSCC is not very much used as a routine. However, care should be taken when QMSCC is used in research as the SCC during one milking will vary tremendously according to the fraction that is sampled and analyzed during milking as demonstrated by Sølverød et al. (2005).

Figure 4. The incidence density of different udder health treatments as cows treated per cow and year during the period 1975 to 2005

4. MEASUREMENT OF CLINICAL MASTITIS (CM)

Just as for SCC the measurement of clinical disease has some pitfalls. Very frequently it is difficult to identify how disease incidence has been estimated in various papers. As demonstrated in the IDF recommendation (IDF, 1997) the estimate of incidence in one and the same material can vary from 0.16 to 0.49 depending on the method of calculation that has been used. The numerator and denominator have to be very clearly defined. These figures traditionally vary from country to country. In principle, as in the case of SCC, there are two levels for presenting clinical mastitis (CM), at herd level and at cow level.

At herd level we wanted to present the CM incidence as a density. As numerator cows treated or cases treated could be used. As denominator the number of days, months or years at risk should be used according to which period is appropriate. These figures are calculated to be 0.25 cases per cow-year and 0.20 cows treated per cow-year during the last three years.

At cow level it is the incidence risk that could be estimated. The exact cumulative risk of a cow being treated during one year was 0.186 in 2004. Estimated stratified at each lactation this number is 0.133 in the first parity, 0.185 in the second, 0.226 in the third, 0.251 in the fourth, 0.266 in the fifth and 0.257 in higher parities. The cumulative risk stratified at parities as lactation proceeds is illustrated in Figure 5.
It is obvious that if incidence densities or risks for CM are to be estimated properly one needs both a recording system for clinical disease and a recording system for calving date, parity number and culling date. From these data both the numerator and the denominator can be calculated, as well as cows at risk, for each day in parity. In Norway and in other Nordic countries all these data are incorporated in the animal recording system although the recording of health is managed in different kinds of systems in the different countries.

![Accumulated risk for a cow being treated for clinical mastitis as lactation proceeds, stratified on parities. From Norwegian data from 2004](image.png)

**Figure 5.** Accumulated risk for a cow being treated for clinical mastitis as lactation proceeds, stratified on parities. From Norwegian data from 2004

### 5. RELATIONSHIP BETWEEN SCC AND CLINICAL MASTITIS (CM)

Research is important to reveal associations between exposure factors and disease as well as the benefit of the diagnostic parameters used to determine prognosis for cows. Such parameters would be important tools in dairy management at herd level.

Traditionally it has been stated that there is a connection between BMSCC and incidence rate of CM. However, from our Norwegian data there is no such relationship, as demonstrated by Valde et al. (2000). This can also be confirmed by the Norwegian data from all herds above 28 dairy cows (n = 1000), shown in Figure 6.
The association between BMSCC and CM in Norwegian herds having more than 28 cow-years (n = 1000)

Figure 6 illustrates that there is a negative association between BMSCC and CM at herd level. However, the coefficient of determination is only 0.59 percent. In reality this means zero. From the other data in Norway we found that the association between CMSCC just after calving and CM in the rest of the lactation is very significantly positive. The Cox model shows a hazard ratio of 1.37 (p < 0.001) per unit increase in lnCMSCC. The raw data reveal an incidence of 0.077 for cows with CMSCC < 50,000/ml, 0.105 for those with 50,000 to 99,000, 0.097 in the range 100,000 to 200,000, 0.161 in the range of 200,000 to 400,000 and finally 0.183 for cows with CMSCC after calving of more than 400,000/ml. This trend with significant positive association between CMSCC and CM is further verified in more advanced models.

The relationship between SCC and clinical mastitis (CM) is currently the most debated area in the scientific literature, with findings presented in both directions. As illustrated by our data it is very important to present the data at the correct unit level (cow level). Herd level data will be misleading. These differences between herd and cow level probably illustrate the occurrence of ecological bias which is very common at herd level. Such results can be really misleading. For such epidemiological models the Cox regression models with frailty is the state of art in empiric modeling of this question. The reason for this is that many cows are culled during the lactation. If these cows are not taken in account and censored in the model, as could be done in survival modeling, the results could be misleading. This is due to selection bias as cows with high CMSCC tend to have higher risk of culling. If these cows also have a higher hazard ratio (HR) for CM the chance of selection bias is obvious. Using logistic regressions for such models could therefore be misleading. We also identified a significant frailty effect, which demonstrates that the association could differ from herd to herd. Thus such studies should be done over several herds to be of greater value for the whole population.

6. THE DYNAMICS OF MASTITIS

The most important equation in mastitis control is the equation presented by Dodd (1981) which says that the prevalence (P) = Duration of inflammation (D) times the new incidence rate (NIR), expressed as a percentage of time (duration) or of cows (NIR). Kleinbaum et al. (1982) elaborated this equation further to P = NIR/(NIR+TD) where P=prevalence, NIR = incidence rate and TD the...
termination rate. This equation could be further transformed to \( P = \frac{(\text{NIR} \times D)}{[(\text{NIR} \times D)] + 1}\). Or \( D = P \times [\text{NIR} \times (1-P)] \), which is more correct for common diseases.

From the simplest equation we see there are two possible approaches to decreasing the prevalence of the disease. That is:

- to decrease duration (D) by culling or therapy or,
- to decrease the incidence rate (NIR) by improving the environment thereby removing or reducing the negative effect of risk factors.

To act correctly with respect to these two points it is very important to know what bacteria are commonly present, both at herd level to build up a proper program for the specific herd and at national level to built up a proper national control program. Thus the herd program has to be based on knowledge of pathogens in the herd. This is information obtained by regular sampling of cows with high CMSCC and/or CM cases. At national level this has to be done by national surveys. Examples of such surveys are the two from Finland (Pitkälä et al. 2004) and Norway (Østerås et al. 2006). The Finnish survey is repeated periodically every ten years and illustrates the importance of such surveys as the pathogenic panorama has dramatically changed over the years. This demonstrate the need for a variety of control programs as therapy cure and culling effect are different for different pathogens as well as for the reservoir of pathogens and termination rate (TD) is also different.

7. REDUCING DURATION OF INFLAMMATION (D)

The papers of Sol et al. (1994) and Østerås et al. (1999) illustrate that CMSCC is the overall most important tool on which to base a herd management program for culling or dry cow therapy of *Staphylococcus aureus*. The cure rate of *S. aureus* according to CMSCC (geometric means of three last counts before drying off) is illustrated in Figure 7. From this figure we see that both self cure rate and cure rate are associated with the level of CMSCC. The real effect of therapy will be greatest in the area of CMSCC between 100,000/ml and 600-700,000/ml. Above 600-700,000 the cure rate will be poor and these cows routinely are recommended to be culled at an appropriate time in lactation. Both therapy and culling should be done at the most economically effective time in lactation. For cows below 100,000 we do not recommend dry cow therapy as the cure rate would be good anyway. From these data we have built up a national selective control program for dry cow therapy based on scientific epidemiological control therapy trials.

Figure 7 illustrates how a strategic therapy program can be built up according to diagnostic information that is available at farm level through the animal recording system. It is important that this information can be further improved by additional information on bacteriological and clinical findings at individual and herd level. The response curves in Figure 7 will obviously differ for different bacteria and different herds. Figure 7 relates to the cow and herd variables indicated in the figure and the curve would be different if any of these variables were different.
8. REDUCING NEW INFLAMMATION RATE

To reduce the incidence rate it is important to attack and reduce the effect of all relevant risk factors. To do this it is necessary to have knowledge of the odd ratio (OR) or relative risk (RR) of the risk factor as well as the exposure rate in the population. From this the population attributable fraction ($AF_p$) can be estimated. According to Dohoo et al. (2003) $AF_p = AF_e \times (a_1/m_1)$, where $AF_e = (RR - 1)/RR$ or approximately $(OR-1)/OR$. The fraction $(a_1/m_1)$ is the number of animals exposed in the diseased group divided by number of animals exposed. In order to correct the important risk factors one should take both $AF_p$ and the cost of correcting these factors into account.

Table I illustrates some selected risk factors for mastitis from previous Norwegian researches just as an example. The following comments could be made on the risk factors presented:

Excessive air inlet when taking off clusters at the end of milking has a large RR and relative low exposure rate. Because of this, the attributable fraction is 0.14. The risk factor is easy to correct if the herdsman is aware of it and motivated to correct it. This means demonstrating the effect during the milking process which is fairly easy with to-day’s equipment. However, the advisor has to be at the farm during milking and make measurements. This exercise is rather costly, but correcting the risk factor does not cost anything other than changing routines. The effect of the correction however, would be fairly large in a specific herd that had such a problem.

The slope of pipeline has a fairly low RR but the exposure rate is very high. Thus the attributable fraction will be high. This is probably the most important risk factor in highline milking machines in Norway. The factor is fairly costly to correct and could also change during time. Correcting the factor could also be in conflict with other building constructions at the farm. This is probably why the factor is commonly encountered. In consequence an extra effort would be required to make a national correction. This is why a national action plan for correction of slope was set up in Norway in 2003. Owing to the lower RR the effect would not be that large at the herd level.
Table I. **Selected risk factors of *Staphylococcus aureus* mastitis and teat tramp with calculation of odd ratio, exposure rate and population attributable fraction**

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Reference</th>
<th>Risk ratio</th>
<th>Exposure rate</th>
<th>Attributable fraction population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive air inlet when taking off cluster</td>
<td>Østerås &amp; Lund (1988)</td>
<td>2.67 <em>(S.aureus)</em></td>
<td>0.10</td>
<td>0.14</td>
</tr>
<tr>
<td>Lack of slope of pipeline</td>
<td>Østerås &amp; Lund (1988)</td>
<td>1.77 <em>(S.aureus)</em></td>
<td>0.37</td>
<td>0.26</td>
</tr>
<tr>
<td>Too short d-phase in pulsator</td>
<td>Østerås <em>et al.</em> (1995)</td>
<td>1.16 <em>(teat tramp)</em></td>
<td>0.50</td>
<td>0.08</td>
</tr>
<tr>
<td>Selenium supplementation with blood values from 0.03 to 0.14 μg/g blood</td>
<td>Kommisrud <em>et al.</em> (2005)</td>
<td>1.65</td>
<td>0.25</td>
<td>0.12</td>
</tr>
</tbody>
</table>

According to Østerås *et al.* (1995) one of the risk factors for teat tramp is having the d-phase of the pulsator too short. The RR is very low, but the exposure is high, thus increasing the AFp to 8%. This risk factor is very cheap to correct, by changing the pulsator ratio from 0.71 to 0.60. This has been done since the 1990’s and could be one of the reasons why the incidence of teat tramp has decreased. Pulsator ratios of 0.71 probably do not exist any more.

All these factors demonstrate that AFp and motivation/economics are very, very important in reducing the incidence rate. The same argument could be used with breeding for mastitis resistance. We know that the breeding value for CM is fairly low at a level of 0.03. However, if one selects over time and changes all bulls over to good ones the “non-exposure” rate would “equal” 100%. In this way the AFp would be rather high, as demonstrated by Heringstad *et al.* (2003). This study showed a 0.27 % units reduction per year of CM in Norway is due to the breeding program from 1990 to 1996.

Recognizing that the risk factors and the exposure rate are very important for the AFp we can conclude that it is important to do new research to evaluate changes of risk factors, both in exposure and importance. This is crucial to build up a correct control program concentrating on the most important risk factors and those having the greatest economic effect.

9. **PRACTICAL REPORTS TO FARMERS**

As the equation P = NIR times D is important these measurements are continuously presented at herd level in the regular farmers reports that are also available for advisors and veterinarian practitioners. The same is true of CMSCC series and other relevant information at cow level. All data are integrated, together with the bacteriological findings from mastitis laboratories.

10. **OVERALL MASTITIS ECONOMICS**

The ultimate goal for the farmer will be to get as much profit out of his/her business as well as maintaining good animal welfare and a good lifestyle for himself and the family. Mastitis therefore has both a welfare aspect and an economic aspect. In economics one has to deal with all aspects of lost resources. That means milk quality, production loss, milk discarded, veterinary fees, medication, replacement animals and labor costs. This is all outlined in a recent IDF paper and does not need to be elaborated on here (IDF, 2005). Under Norwegian conditions all relevant parameters concerning mastitis are regularly reported to the farmers. These parameters are CMSCC, bacteriology, CM, prevalence, incidence rates, duration of inflammation as well as the total economic effect. The tools are all available. The task now is to educate all farmers, veterinarians and advisors to use them in a proper way.
11. CONCLUSION

Mastitis is a very dynamic disease at cow level, herd level and country level. Additionally the movement of animals is very dynamic as cows are continuously introduced into the herd and removed from it. This makes calculations of incidence rate difficult and there are plenty of pitfalls present. Bacteriology and risk factors are continuously changing and a proper control program has to be adjusted to the current situation. Control programs acting on *S. aureus*, coagulase-negative staphylococci (CNS), *Streptococcus dysgalactiae*, *S. uberis* or *Escherichia coli* should be different and adjusted to the ecology of the bacteria and their respective pathogeneses. Regular surveys are “a must” to know the “enemy” at herd level and national level. The dynamics of infection can be estimated and presented for the herd as well as the total economic consequences of mastitis. As the dynamics of the population are large, with the removal of many cows during lactation, care should be taken to avoid selection bias in reaching conclusions about mastitis epidemiology. The effect of animals clustered within herds underlines the benefit of Cox regression models including frailty effects when dealing with events as dependent variables. Additionally the large herd effect for many factors leads to the conclusion that results from a single herd study should be interpreted with great care.

12. SUMMARY

Mastitis is a very dynamic disease within dynamic populations where animals are replaced all the time. This makes description of disease measurement parameters difficult. It is important to define the numerator and denominator very clearly, as well as time under observation. For populations incidence density (cases per cow-year) is a good measure and at individual level incidence risk (the risk of experiencing the disease during a specified time limit). Prevalence at a specific time is dependent on the mean duration of inflammation and the new inflammation rate. The duration can be reduced by proper treatment of animals expected to respond to therapy or culling of chronically infected cows that are non responders. Both therapy and culling should be done at the most economically effective time in lactation. Cow milk/composite somatic cell count (CMSCC) is the most important regularly available tool so far for selecting cows for therapy or culling. The CMSCC must be managed in the proper way as log data and taking more than one count into consideration when the data are used. The new inflammation rate could only be reduced by diminishing the impact of risk factors. The importance of these risk factors should be judged according to the population attributable fractions as well as the ease of correcting them and the resources needed to do so. The most important risk factors are found in hygienic condition, milking procedure, milking machine, stall environment or feeding. The correct risk factor and treatment strategy will vary over time as will also the pathogens involved in the inflammation. It is therefore a must to have access to updated surveys of both pathogens and risk factors to adjust a correct control program in the specified time and place whether at country or herd level.

13. KEY WORDS

Mastitis, incidence measures, mastitis control, duration, risk factors.

14. RESUME

La mammite est une maladie très dynamique chez les populations d’animaux dans lesquelles on remplace les animaux de façon continue. Ce phénomène rend difficile la description des paramètres de mesure de la maladie. Il est important de définir très clairement le numérateur et le dénominateur, ainsi que la période sous observation. Quand il s’agit de populations, l’intensité des incidences (nombre de cas par année-vache) est un bon paramètre. Au niveau des individus, le risque d’incidence (risque d’apparition de la maladie lors d’une période spécifiée) est également
bon. La fréquence à un moment déterminé dépend de la moyenne de la durée d’inflammation et du taux de nouvelles inflammations. Cette durée peut être réduite par un traitement correct des animaux susceptibles de bien réagir à la thérapie ou l’élimination sélective de vaches qui subissent des infections chroniques et qui ne réagissent pas aux traitements. La thérapie et l’élimination sélective doivent être appliquées au moment de la lactation le plus propice d’un point de vue économique. Jusqu’à présent, la teneur en cellules somatiques au niveau de la vache (CMSCC) est l’outil le plus important à disposition régulière pour la sélection des vaches pour thérapie ou élimination. Ce paramètre (CMSCC) doit être géré de façon correcte, comme donnée logarithmique, et en prenant plus d’un dénombrement en compte au moment de s’en servir. Le taux de nouvelles inflammations n’a pu être réduit qu’en diminuant l’impact des facteurs de risque. L’importance de ces facteurs doit être jugée selon la proportion de la population à laquelle ils peuvent être attribués, ainsi que selon la facilité de les corriger et les ressources nécessaires pour le faire. Les facteurs de risque les plus significatifs se trouvent dans les conditions d’hygiène, la procédure de traite, les machines à traire, l’environnement de l’étable ou l’alimentation. Le facteur de risque et la stratégie de traitement correcte varieront avec le temps, tout comme les pathogènes impliqués dans l’inflammation. Il est donc essentiel d’avoir accès à des données récentes sur les pathogènes et les facteurs de risque afin de permettre l’adoption d’un programme de lutte contre la maladie à un moment donné et dans un lieu donné qu’il s’agisse du niveau national ou du niveau du troupeau.

15. MOTS CLES
Mammite, intensité des incidences, programme de lutte, durée, facteur de risque.

16. ZUSAMMENFASSUNG

17. SCHLÜSSELWÖRTER
Mastitis, Erkrankungsdichte, Bekämpfungsprogramm, Dauer, Risikofaktoren.
18. RESÚMEN

Mastitis es una enfermedad muy dinámica dentro de poblaciones dinámicas donde los animales son substituídos todo el tiempo. Esto hace difícil la descripción de los parámetros de medida de la enfermedad. Es importante definir el numerador y el denominador muy claramente, así como también el tiempo de observación. La incidencia de la densidad de poblaciones (casos de vacas al año) es una buena medida y al nivel individual el riesgo de incidencia (el riesgo de experimentar la enfermedad durante un límite de tiempo específico). La prevalencia en un momento específico es dependiente de la duración de la inflamación y el nuevo grado de inflamacion. La duración se puede reducir por el tratamiento apropiado de los animales que se espera que reaccionen a terapia o a una selección de vacas infectadas crónicamente que no reaccionan a tratamiento. La terapia y la selección se deben hacer en el tiempo lo más económicamente eficaz de la lactancia. La leche de vaca/compuesto somático de la cuenta de célula (CMSCC -abreviación en inglés) es todavía la herramienta regularmente disponible mas importante para seleccionar las vacas para terapia o desecho/selecion. La CMSCC se debe manejar de la manera apropiada; esto se refiere al uso correcto de la informacion acumulada y a tomar más que un registro de una cuenta en la consideración cuando la informacion se utilice. El nuevo grado de inflamación podrá solamente ser reducido por la disminución del impacto de los factores de riesgo. La importancia de estos factores de riesgo se debe juzgar según sus fracciones atribuibles de la población, así como la facilidad de corregirlos, y los recursos necesarios para hacerlo. Los factores de riesgo más importantes se encuentran en la condición higiénica; el procedimiento de ordeño, la máquina de ordeño, el ambiente de el establo y/o la alimentación. La estrategia correcta para el factor de riesgo y de tratamiento variará en el tiempo también como los patógenos implicados en la inflamación. Es por lo tanto un deber tener acceso a exámenes/registros actualizados de ambos patógenos y factores de riesgo para ajustar un programa de control correcto en el tiempo y lugar especificado (nivel de país o manada).

19. PALABRAS CLAVES

Mastitis, incidencia, programa de control, duración, factores de riesgo.

20. REFERENCES


