SOME PROBLEMS WHEN PRESENTING OCCURRENCE OF DISEASES – KETOSIS AS EXAMPLE

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Introduction: Standardization of the methods used to present disease occurrence is important when comparing disease situations in different populations, and when comparing results from different studies. Descriptions on how to present disease occurrence are found in epidemiological textbooks (1). Still different and often very confusing presentations are found in the literature. For this reason the International Dairy Federation has made a separate recommendation on how to present mastitis data (2). The objectives of this paper are to describe and present how the different ways of calculating incidence rate, cumulative risk, and simple proportions affect the result. Some pitfalls and sources of errors are discussed. Occurrence of ketosis in Norway during 1997 is used as example.

Material and methods

All cows in the Norwegian dairy herd recordings system during 1997 are included, representing 92% of all dairy cows in Norway. They constitute an open cohort of 433,111 cows from 21,508 farms, observed from January 1st to December 31st of 1997. In total they make up 284,351 cow-years in production i.e. time spent in a herd from first calving till slaughter. The original data are stored in a database owned and run by the TINE Norwegian Dairies on behalf of the milk producers, and transferred to the copy database, KKVet, at the Norwegian School of Veterinary Science. This data set containing exact information on calving date, culling date and disease date made it possible to do exact as well as approximate calculations on disease rates, risks and proportions.

The following rates, risks and proportions were calculated:

1) Exact incidence rate (number of cows having had one ketosis treatment divided by number of cow-years at risk).
2) Approximate incidence rate (number of cows having had one ketosis treatment divided by the total number of cow-years).
3) Estimated cumulative risk, estimated by the equation $1-e^{-(\text{exact incidence rate} * \text{time})}$.
4) Approximate cumulative risk (number of cows with ketosis divided by the sum of: number of cows with ketosis + number of cows without ketosis and full observation time + half of the numbers of cows without ketosis without full observation time).
5) Exact cumulative risk, day by day (accumulated risk for a cow of having ketosis until a certain day i.e. one minus survival function). Survival function was defined

as: (1- risk of having ketosis on day d)*(1- accumulated risk of having ketosis on day (d-1)).

6) Proportion of all cows that experienced ketosis (including also cows being in the cohort only a part of the year).
7) Exact cumulative risk per lactation i.e. lactation specific.
8) Estimated cumulative risk per lactation i.e. lactation specific.

Results

Of the 433,111 cows 25,240 had experienced at least one ketosis during the year.

The results of the calculations were as follows:

1) Exact incidence rate: 0.0913 ketosis per cow-year.
2) Approximate incidence rate: 0.0888 per cow-year.
3) Estimated cumulative risk: 0.0873 per cow and year.
4) Approximate cumulative risk: 0.0809 per cow and year.
5) Exact cumulative risk: 0.0711 per cow and year.
6) Proportion of cows experiencing ketosis: 0.0583.
7) Exact cumulative risk per lactation, L1 to L5 (Figure 1):
   L1: 0.043 L2: 0.069 L3: 0.096 L4: 0.108 L5: 0.106
8) Estimated cumulative risk per lactation, L1 to L5:
   L1: 0.051 L2: 0.086 L3: 0.123 L4: 0.145 L5: 0.149

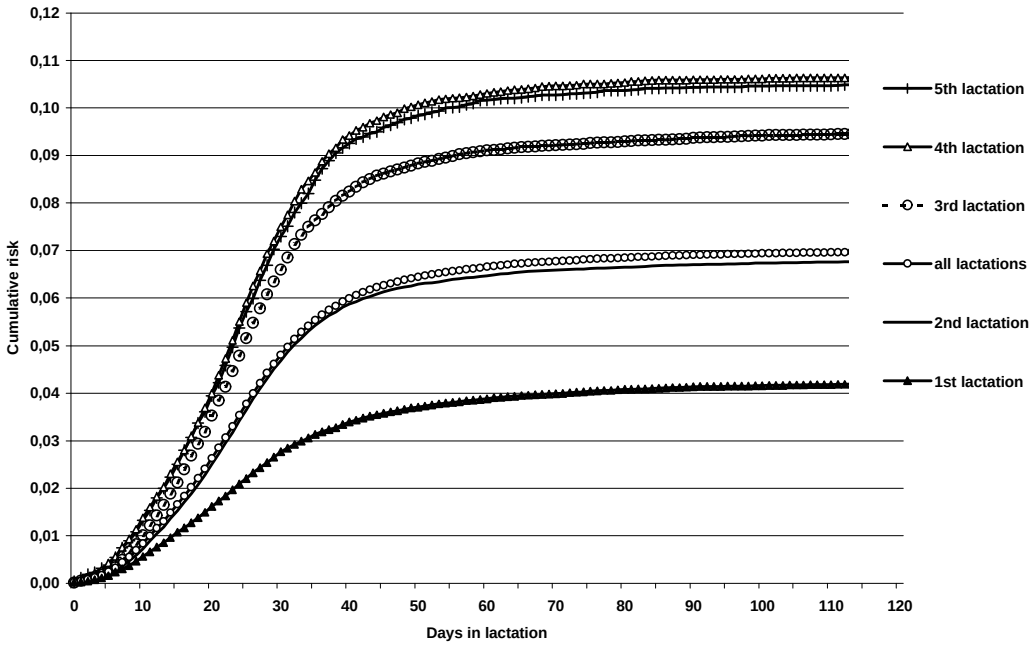

Figure 1. Cumulative risk of a cow being treated for ketosis according to lactation number and days in lactation.

Discussion

The results show that the different measures of ketosis in the Norwegian cattle population for the same calendar year can vary from 0.058 to 0.091 i.e. by 57% just by changing method of calculation.

The exact incidence rate of treatments for ketosis in the Norwegian dairy cattle population was 0.0913 per cow-year. Approximate incidence rates will underestimate ketosis because the denominator also includes the time after the cow has experienced one case of the disease. This error will increase as the incidence rate increases.

Estimated cumulative risk as well as approximate cumulative risk will overestimate ketosis. This overestimation is due to the fact that ketosis is not a disease that occurs with constant rate during the complete lactation. As Figure 1 illustrates the risk of having ketosis after day 80 in lactation is very low compared to the period before. The approximation obtained by using the formula given in (1) is therefore not correct.

Proportions of cows or lactations should be avoided as the observation time is not known. Despite of this so-called "frequencies" of disease are often reported in this way. These proportions will under estimate the disease occurrence, as the culling rate in dairy population is usually very high.

Exact lactation specific cumulative risk (Figure 1) gives very precise information on disease occurrence, but may be difficult to obtain and use except for research purposes.

Approximate lactation specific cumulative risk (not illustrated) will dramatically overestimate the risk of diseases like ketosis that have the high risk period shortly after calving and should not be used.

Experiences from this data and reading from literature strongly demonstrate the need for a standard for presenting disease occurrence in populations. From literature we often se presentation like number of cases per cow per year. This can be interpreted in different ways and is thus not adequate. In our example data set this could mean any of the results numbered 1 to 6, i.e. any occurrence between 0.058 and 0.091.

There is still a need for a golden reference standard on how to present disease rates and risks. Publications using these measures should describe in detail how the disease incidence rates or disease cumulative risks are calculated, including a precise definition of the nominator and the denominator used.

References:

1 Martin SW, Meek AH, Willeberg P. Measurement of disease frequency and production. In: Veterinary Epidemiology. Ames: Iowa State University Press, 1987: pp 48-76.

2 International Dairy Federation. Recommendation for presentation of mastitis-related data. Bulletin 321/1997. International Dairy Federation 41, Square Vergote, Brussels, 1997: pp. 6 – 25.