

DESCRIPTIVE EPIDEMIOLOGY AND MULTIVARIATE ANALYSES OF BOVINE ABORTIONS

Markusfeld - Nir O.¹

Le diagnostic étiologique des avortements n'est pas fréquemment posé, et l'épidémiologie pourrait constituer un outil d'aide à l'interprétation des résultats de laboratoire dans l'investigation de ce problème. Quoique des méthodes standardisées de mesure des risques d'avortement aient été développées, les analyses multivariées sur le risque d'avortement sont rares. La présente étude décrit une méthode utilisée pour l'analyse des avortements dans les élevages, et des types d'avortements dans les élevages israéliens. Un suivi régulier des avortements est réalisé, les rapports adressés aux élevages comprenant des données épidémiologiques descriptives et une analyse multivariée. Les données sont présentées en fonction de la parité, du trimestre, des courbes d'avortement et du taureau. Les résultats sont présentés sous la forme du nombre d'avortements pour 10 000 vaches-jours à risque, du pourcentage de vaches ayant avorté, d'avortements par gestations confirmées, et des odds ratios ajustés. Les odds ratios du risque d'avortement pour 10 000 vaches-jours à risque sont calculés selon une méthode adaptée du Mantel-Haenszel. Les facteurs de confusion potentiels sont choisis en fonction de leur disponibilité et de leur effet abortif potentiel. Le temps, la parité et le trimestre de gestation sont utilisés dans tous les modèles. 58048 gestations provenant de 111 élevages ont été analysées. La densité moyenne d'avortements était de 4.2 pour 10 000 vaches-jours à risque. Dans 21.6% des élevages étudiés, aucun pic d'avortements n'a pu être mis en évidence. Les génisses présentaient le taux le plus bas d'avortements, et les vaches de parité 2 le plus élevé. Le risque le plus élevé de mort fœtale était observé durant le premier trimestre de gestation et le risque le plus faible au cours du second trimestre. Le risque ratio de récurrence d'avortement au cours de la même lactation était élevé. Le risque d'avortement suite à la naissance de jumeaux était plus élevé. Le risque d'avortement était plus élevé en automne et au début de l'hiver que durant les mois d'été. Le risque d'avortement était plus élevé pour les vaches fécondées par un taureau porteur de BLAD (bovine leukocyte adhesion deficiency).

Abortions are defined as a "loss of pregnancy" in the period between 42 (the rectal examination) and 260 days of gestation. Successful diagnosis of etiology of abortion is infrequent (perhaps 29%-30% in various laboratories) (Miller, 1986), epidemiological tools could help in narrowing down the field of investigation for a better interpretation of laboratory results. The present study compares various methods used to measure risk of abortions, describes a multivariable method which could be used in analyses of abortion risk, and the patterns of abortions in Israeli herds using the above methods (Markusfeld-Nir, 1997).

SCOPE AND RATES OF ABORTIONS

Data on production, fertility and health of all Israeli Kibbutz dairy herds are recorded routinely and stored in the Israeli Holstein Herd Book. Routine reports which include monitoring and causal analysis of calving traits, fertility, and production are issued to most Kibbutz herds every four months (Markusfeld-Nir, 1996). Reports of abortions, which include both descriptive epidemiology and multivariable analysis, are issued annually.

Fifty-eight thousand and forty-eight pregnancies in 111 (out of a total of 200 Israeli "Kibbutz" herds) in 1995 were included in the study. Three thousand four hundred and eight out of 58,048 pregnancies terminated in abortions. Our median abortions per confirmed pregnancy (9.3%) was higher than the 6.5% calculated in a review of 26 studies from 6 countries over the last 5 decades (Forar et al., 1995). Fetal losses in another study using abortions per confirmed pregnancy risks with similar periods of risk was 8.4% in a study involving 19,411 cows in California (Thurmond et al., 1990). Calculated abortion "rates" in three different ways correlations were high among them (Table I). Risks that express proportions of aborted cows do not account for changes in risk over gestation time as does cumulative abortion incidence, but the measures are relatively close if all the pregnancies are detected within a narrow interval of gestation. They also avoid the difficulty of determining the gestational age at which the abortion occurred, which is often difficult to establish (Forar et al., 1995). Abortion densities are also limited because a heavier weight is given to early abortions.

Table I
Annual bovine abortion rates (58,048 pregnancies in 111 Israeli Kibbutz dairy herds, 1995)

Method of calculation	Range	Lower quartile	Median	Upper quartile	r^a
Abortions per 10,000 cows-days-at-risk	1.3-8.6	3.1	3.9	5.2	---
Proportion of aborted cows (%)	1.6-11.2	4.5	5.5	7.0	.957
Abortions per confirmed pregnancy (%)	3.1-20.8	7.6	9.3	12.5	.977

^a Correlation coefficients (Spearman Rank Order) with abortions per 10,000 cows-days-at-risk at herd-level; both $p < 0.001$

¹ Hachaklait" the Mutual Society for Insurance and Veterinary Services in Israel. 57 Balfour Street Nahariyya, 22426, Israel

MULTIVARIABLE ANALYSIS

Potential confounding factors were chosen for their availability and their potential abortifacient effects. Due to the limited number of observations in a given herd, the number of variables we can use in any single herd is limited. Odds ratios for abortion by the various parity, trimester, calendar months, twinning vs. singleton birth to begin that lactation, and sire were calculated using the modified Mantel - Haenszel method (Erb and Martin, 1980). The various odds of a cow with the examined factor to abort were compared to that of all others pooled together. All rates were for abortions per 10,000 cows-days-at-risk. Strata used in the various Mantel - Haenszel calculations are in Table II. Risk of recurrence to abort was presented in terms of odds ratio of a population with a previous abortion in the same parity to abort, compared with a population without such a history (Markusfeld, 1990).

Table II
Subcategories used in the calculation of the various odds ratios

The examined factor	Strata used for calculation of Mantel-Haenszel odds ratios
Parity	Herd, trimester, calendar month
Trimester	Herd, parity, calendar month
Twinning	Herd, parity (2nd, 3rd, 4th, >4th)
Calendar month	Herd, parity, trimester
Sire	Herd, calendar month, parity, trimester
Repeatability	Herd, parity

THE ABORTION CURVE (BY TIME)

The abortion curve is important in the investigation of bovine abortion in a herd. The curve is influenced by the nature of the abortifacient, the length of the latent period, the rate and mode of infection, and the sensitivity of the population at risk. The level of disease may be referred to as "epidemic" if it exceeds two standard deviations above the mean (Martin et al., 1987). In our models, peaks of abortions are defined when the odds of aborting in a calendar month is greater than for the rest of the year pooled together. Peaks should be separated from the previous or next ones by at least one period (month). One, two, and three peaks were so established in 53.2%, 24.3%, and 0.9% of the herds, monitored respectively.

PARITY

Risks of abortion in heifers were lower than in cows in all methods used (Table III). Rate of abortions per 10,000 cows-days-at risk was significantly higher for second parity. Different risks for the various parities might reflect different degrees of immunity (first or consecutive exposures) to the agent. Heifers in our sample are reared on the farm but kept in a separate group (as are the first-parity cows in most farms). It is possible that in many of our herds heifers with low or no immunity are exposed to the abortion agents when first introduced into the milking herd.

Table III
Abortion in the various parities

Parity	Heifers	First	Second	Third or over
Abortion rate per 10,000 cows-days-at -risk	3.0 ^a	4.7 ^b	5.3 ^{bc}	4.5 ^{bd}
Abortion rate (%) ^e	4.5	19.8	19.8	17.1
Odds ratio ^f	0.6**	1.2**	1.3**	1.2**

^a Percentage of the herds with a statistical-significant odds ratio of a cow in the parity to abort compared to that of all other parities pooled together. ^f Odds ratio compared to all other parities pooled together, and adjusted for herd, trimester of gestation, and calendar month.

** $p < 0.01$ ^{a,b}. For different letters within row, $p < 0.001$. ^{c,d}. For different letters within row, $p < 0.05$

STAGE IN GESTATION

Some abortifacients are "trimester specific" (Radostits and Blood, 1985). In our sample (Table IV) odds of aborting in the first trimester were greater, and those in the second trimester lower than those in the other trimesters pooled together.

Of 25,580 calvings of multiparous cows in our study, 5.5% were deliveries of twins. The proportion of aborted cows after twinning was greater than after a single calf (8.2% and 6.2%, respectively; odds ratio = 1.3, $p < 0.05$). Cows with twin pregnancies had twice the risk of damage from the palpation in one study (Day et al. 1995). A high repeatability (recurrence risk ratio = 2.0) was found for twinning in a previous study (Markusfeld, 1990). The relatively high rate of twins in our population, the greater risk of damage from palpation, and the high repeatability of the trait could partly explain the greatest risk for cows to abort in the first trimester.

Table IV
Abortion in the various trimesters of gestation

Trimester	First	Second	Third
Abortion rate per 10,000 cows-days-at-risk	8.3 ^a	3.8 ^{bc}	5.2 ^{bd}
Abortion rate (%) ^e	44.1	0.9	18.9
Odds ratio ^f	1.9**	0.6**	1.1

^e Percentage of the herds with a statistical-significant odds ratio of a cow in the trimester to abort compared to that of all other trimesters pooled together. ^f Odds ratio compared to all other trimesters pooled together, and adjusted for herd, parity, and calendar month.

** $p < 0.01$ ^{a,b,c,d} For different letters within row, $p < 0.001$

REPEATED ABORTIONS

Nine hundreds and three cows out of 3408 cows (26.5%) that aborted were reinseminated, and conceived in the same lactation. The proportion of aborted cows with a previous abortion in the same lactation was higher than that of the whole population (17.5% and 5.9%, respectively). The recurrence risk ratio of aborting (adjusted for herds and parities) was 2.7 ($p < 0.01$). Repeated abortions in cattle are rare (Barr et al., 1990) and expected in trichomoniasis, neosporosis and listeriosis. They are also possible in brucellosis and after infection with various strains of leptospirosis (Miller, 1986).

SEASONAL EFFECTS

Our findings show an increased abortion density in the late autumn and early winter months (November to January). Many herdsmen complain about an apparent rise in abortion during the summer months. The reason behind that "optical illusion" is understood from our sample, the number of cows that abort in the summer months is high, but so is the population at risk.

THE SIRE

Semen of 233 bulls was responsible for the 58,048 pregnancies in our study. Increased risk aborting was greater in cows inseminated by 8 of the bulls. While the proportion of aborted cows sired by all bulls was $5.9\% \pm 2.0\%$ (SD), that of the above 8 bulls ranged from 10.6% to 17.9%. Higher risks for specific bulls might reflect a genetic failure (Norton and Campbell, 1990) or an infectious agent transmitted by sexual contact or through infected semen. Our AI centers are free from known transmitted infectious diseases that cause abortion.

Bovine Leukocyte Adhesion Deficiency (BLAD) is a recessive autosomal inherited disorder in Holstein cows. Only recently, bulls at the AI centers in Israel were screened for the gene. Out of the above 8 bulls, 2 out of the 3 bulls tested were BLAD positive. In view of that results, we used bulls with more than 30 pregnancies in the sample we had (all of first lactation cows) to evaluate the association between abortions and bulls carriers of BLAD. Proportion of aborted cows (%) for the whole sample was 5.4%. Risks of abortion for 2 out of 3 positive bulls were significant (O.R. of 4.2 and 2.3 respectively). Risk of abortion was significant for only 1 out of the 16 negative bulls (O.R. of 2.4). We later used data from previous period to compare 216 pregnancies of another BLAD positive bull to 1070 pregnancies of BLAD negative ones. Proportions of aborted cows (%) were 12.5 and 6.7 respectively. Odds Ratio aborting was 2.0 ($P < 0.01$). The possible association of abortions with BLAD had not been described before and needs further clarifications.

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