GENETIC EVALUATION OF STILLBIRTH IN UNITED STATES HOLSTEINS USING A SIRE-MATERNAL GRANDSIRE THRESHOLD MODEL

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INTRODUCTION

Genetic evaluations for calving ease have been computed in the US since 1977 (Berger, 1994; Van Tassell *et al.*, 2003), but evaluations are not provided for other traits related to calving, such as calf livability. Stillbirths, calves born dead or that die within 48 h of birth, are of increasing interest to US dairy producers. In a study of calf mortality, Patterson *et al.* (1987) found that 65.7% of all calf losses occur within 48 h of parturition. In addition, the stillbirth rate increased from 9.5% in 1985 to 13.2% in 1996, costing producers $125.3 million per year (Meyer *et al.*, 2001a). The purpose of this study was to determine the feasibility of implementing a genetic evaluation for stillbirth (SB) in US Holsteins.

MATERIAL AND METHODS

Data. Holstein calving ease and stillbirth records for herds reporting at least 10 stillbirth scores were extracted from the AIPL database. About half of the 10.5 million calving ease records in the database have a known livability score, most of which originated from DRMS (Raleigh, NC), and. All records were subjected to a series of data quality edits (Van Tassell *et al.*, 2003). Calf livability scores of 2 and 3, representing calves born dead and calves that died within 48 h of parturition, respectively, were combined into a single category. Herds were required to have reported at least 10 calf livability scores to be included in the analysis. Frequencies of stillbirth and calving ease scores are presented in Table 1. A total of 92,259 bulls were represented, 41,507 of which were AI bulls.

Table 1. Distribution of stillbirth and calving ease scores.

	Stillbirth Score[B]				
Calving Ease Score[A]	0	1	2	3	Total
1	1,287,290	4,343,140	158,250	20,418	5,809,098
2	203,738	482,720	49,858	2537	738,853
3	183,951	375,203	70,522	3353	633,029
4	59,614	108,037	37,851	1740	207,242
5	23,690	38,929	32,196	1272	96,087
Total	1,758,283	5,348,029	348,677	29,320	7,484,309

[A]Calving ease scores are: 1 = No problem, 2 = Slight problem, 3 = Needed assistance, 4 = Considerable force, 5 = Extreme difficulty.
[B]Stillbirth scores are: 0 = No score reported, 1 = Calf born alive, 2 = Calf born dead, 3 = Calf born alive but died within 48 h of birth.

Genetic Evaluation Model. The sire-maternal grandsire (MGS) model used for the national calving ease evaluation (Van Tassell *et al.*, 2003) was used to analyze the stillbirth data, and included effects of herd-year, year-season, parity-sex, sire, birth year group of sire, MGS, and birth year group of MGS. Herd-year, sire, and MGS were random effects. The model was also extended to include the fixed effect of calving ease score. Parities were first, second, and third and later. Year-season groups began in October and May. Models were fit using the cblup90iod threshold model package (Misztal *et al.*, 2002).

(Co)variance components were estimated from six subsamples of the full dataset using a quasi-REML threshold model procedure (Hoeschele et al., 1995; Misztal et al., 2002) and averaged. Herd-year variance was 0.0839; sire and MGS variances were 0.0083 and 0.0182, respectively, and the covariance between them was 0.0040. The residual variance was set to 1, as is customary with threshold models.

Sire and MGS solutions on the underlying scale were transformed and expressed as the expected percentage of stillbirths in heifers giving birth to male calves (%SBH). Genetic bases for service sire stillbirth (SSB) and daughter stillbirth (DSB) were defined by bulls born in 2000 and 1995, respectively, in a manner analogous to that used for calving ease (Van Tassell *et al.*, 2003). The bases for direct and maternal effects were 11.6% and 13.6%, respectively.

RESULTS AND DISCUSSION

Properties of solutions on the underlying scale for effects in models with and without the fixed effect of calving ease are presented in Table 2. Calving ease scores had larger effects on stillbirth than year-season, sire, or MGS effects as indicated by the range of solutions, which is consistent with Meyer *et al.*'s (2001b) finding that dystocia has a large effect on the mean for stillbirth. Calvings reported as requiring considerable force or extremely difficult were more 1.7 and 2.3 times as likely, respectively, to result in a stillborn calf as calvings scored no problem. Rank correlations of PTA from models with and without the effect of calving ease showed substantial reranking of sires.

Table 2. Number of levels of effects, ranges and SD of solutions from sire-maternal grandsire (MGS) threshold model equations with (CE) and without (No CE) the effect of calving ease.

	Analysis					
	No CE			CE		
Effect	Levels	Range	SD	Levels	Range	SD
Herd-year	86,486	3.47	0.18	86,486	3.95	0.20
Year-season	52	1.07	0.19	52	1.15	0.21
Parity-gender	6	0.61	0.25	6	0.28	0.13
Sire birth year	18	0.08	0.02	18	0.06	0.02
MGS birth year	35	0.23	0.05	35	0.22	0.05
Calving ease	-	-	-	5	1.79	0.68
Sire	92,259	0.48	0.04	92,259	0.43	0.03
MGS	92,259	0.91	0.05	92,259	0.82	0.05

The distribution of sire PTA for SSB and DSB is shown in Figure 1. The distribution of SSB is more compact than that of DSB, which is expected, because the genetic variance of SSB is smaller than that of DSB. Mean PTA for SSB were consistently lower than DSB across sire birth years, and there is no indication of a consistent genetic trend, which confirms the findings of Meyer *et al.* (2001b). Distributions of the reliability of SSB and DSB (Figure 2) are heavily right-skewed and reflect lower progeny numbers than are desirable from the perspective of genetic evaluation. This is likely because a small number of bulls have large numbers of records available, which gives high reliabilities, but most bulls have a very small number of daughters and receive correspondingly low reliabilities. Van Tassell *et al.* (2003) reported a consistent upward bias in reliabilities attributable to the assumption that all relatives and contemporaries are perfectly evaluated.

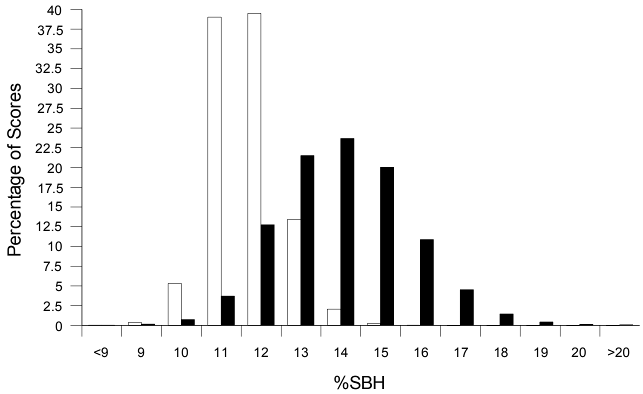

Figure 1. Distribution of all service sire (open) and daughter (shaded) PTA for the percentage of stillbirths in heifers (%SBH)

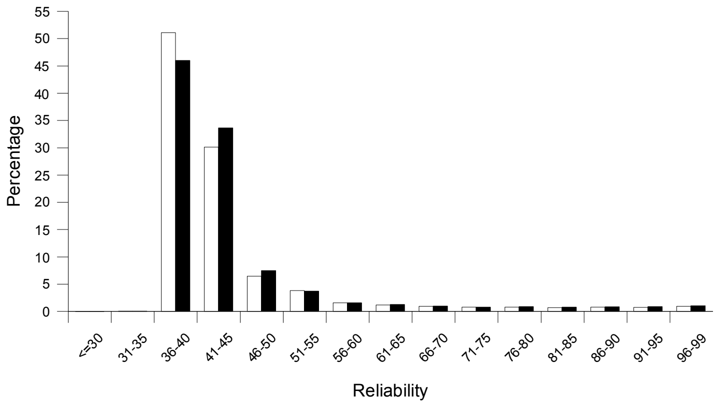

Figure 2. Distribution of all service sire (open) and daughter (shaded) reliabilities for the percentage of stillbirths in heifers

Denmark, Finland, Holland, Sweden, and Switzerland currently participate in the Interbull stillbirth evaluation. Correlations among US stillbirth solutions on the underlying scale with Interbull evaluations on foreign scales for bulls with at least 90% reliability in both countries ranged from 0.63 to 0.90 for direct SB and 0.69 to 0.96 for maternal SB, indicating that results from this analysis are generally consistent with those in other countries. These ranges are similar to the range of correlations among the five Interbull participants. Correlations were not uniformly high due to differences in model and trait definition between countries.

Implementation Issues. Dystocia and calf livability records are reported together, but approximately half of all dystocia records have no corresponding livability scores. An effort is underway to encourage more complete recording of livability scores, which may result in improved reliabilities and allow for evaluations of other breeds. The bases for SSB and DSB are set using the percentage of stillborn male calves to heifers in the given base year, and the resulting PTA are worst-case estimates in that they may be inflated. Much of the variation due to parity-sex effects is attributable to the increased risk of dystocia, and corresponding increased risk of stillbirth, in heifers bearing male calves. When calving ease is included in the model, the magnitude of parity-sex variation decreases by about half. Development of a calving index that combines direct and maternal calving ease and stillbirth evaluations is desirable, and such indices are already provided by Germany, Holland, and Scandinavian countries.

CONCLUSION

A routine genetic evaluation for stillbirth in US Holsteins using a sire-MGS model is feasible and provides results consistent with previous studies using US data as well as Interbull stillbirth evaluations.

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A sire-maternal grandsire threshold model was used for genetic evaluation of stillbirth in US Holsteins. Data consisted of almost 7.5 million records, and over 41,000 AI bulls received evaluations. The model included effects of herd-year, year-season, parity-sex, sire, birth year group of sire, maternal grandsire (MGS), and birth year group of MGS, and dystocia score. Herd-year, sire, and MGS were random effects. Mean PTA, expressed as expected percentage of stillbirths in heifers, were 12.47 and 14.28 for direct and maternal stillbirth, respectively. Reliabilities for the direct and maternal effects averaged 53% and 52%, respectively. Dystocia scores had a larger effect on stillbirth than year-season, sire, or MGS effects. Correlations among US and Interbull stillbirth solutions on the underlying scale for bulls with at least 90% reliability ranged from 0.63 to 0.90 across countries for direct SB and 0.69 to 0.96 for maternal SB, indicating that results were generally consistent with those from other countries. There was no evidence of a consistent genetic trend. More complete recording of stillbirth scores would improve reliabilities and possibly allow for evaluations of other breeds.