Mortality in different management systems

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Abstract

The objectives of our research are to investigate associations of mortality and culling by 60 days-in-milk with herd management systems and to evaluate the impact of sire selection on mortality rate. Herd management surveys were obtained for 314 herds that had mortality rate and 60-day culling rate data available. Mortality and 60-day culling rate were associated with five herd management systems that were identified from survey data: free-stall herds with complete confinement for lactating cows; free-stall herds with some level of outdoor access for lactating cows; tie-stall herds with complete confinement for lactating cows; tie-stall herds that fed a total mixed ration (TMR) and with outdoor access for lactating cows; and tie-stall herds that did not feed a TMR and with outdoor access for lactating cows. Mortality and 60-day culling rates were highest for free-stall herds with complete confinement (8.3% mortality) and lowest for tie-stall herds that did not feed a TMR and with outdoor access for lactating cows (2.0% mortality). Genetic selection for longer productive life reduced mortality in all management systems. The results of this and other studies suggest that intensive management systems (reduced pasture access, intensive feeding programs, free-stall housing) are associated with higher rates of mortality.

Key words: dairy cows, mortality, free stalls, tie stalls

Résumé

Les objectifs de notre recherche sont d étudier les associations entre mortalité et réforme avant 60 jours en lait grâce aux systèmes de gestion des troupeaux, et d évaluer l impact de la sélection des reproducteurs sur le taux de mortalité. Les enquêtes sur la gestion des troupeaux ont été réalisées sur 314 troupeaux pour lesquels des données sur le taux de mortalité et le taux de réforme à 60 jours en lait étaient disponibles. Les taux de mortalité et de réforme à 60 jours en lait ont été associés par cinq systèmes de gestion des troupeaux identifiés à partir des données d enquête : troupeaux en stabulation libre et confinement complet des vaches en lactation; troupeaux en stabulation libre et un certain degré d accès à l extérieur pour les vaches en lactation; troupeaux en stabulation entravée et confinement complet pour les vaches en lactation; troupeaux en stabulation entravée avec ration totale mélangée (RTM) et avec accès à l extérieur pour les vaches en lactation; et troupeaux en stabulation entravée sans RTM et avec accès à l extérieur pour les vaches en lactation. Les taux de mortalité et de réforme à 60 jours en lait étaient plus élevés chez les troupeaux à stabulation libre avec confinement complet (mortalité de 8,3 %) et plus faibles chez les troupeaux à stabulation entravée sans RTM et avec accès à l extérieur pour les vaches en lactation (mortalité de 2,0 %). La sélection génétique pour une durée de vie productive plus longue a réduit la mortalité dans tous les systèmes de gestion. Les résultats de cette étude et d autres études tendent à démontrer que des systèmes de gestion intensifs (accès restreint aux pâturages, programmes d'alimentation intensifs, stabulation libre) sont associés à des taux de mortalité plus élevés.

Introduction

Dairy producers invest significant time and capital in raising dairy replacements.[8] That investment, coupled with the cow's milk production potential and cull value, create a large economic incentive to prevent on-farm death. Despite such economic incentive, there is evidence that mortality rates have risen from historical levels[13] and did so before legislative changes that increased the rate of on-farm euthanization.[14] The average age of our dairy cow population has declined substantially,[10] which makes high mortality rates more troubling.

Many studies have reported an unfavorable relationship between herd size and mortality.[4,13,16] However, the reason cows die on-farm is not recorded on a large-scale basis. This hampers our ability to recognize herd management practices that contribute to elevated mortality and develop strategies to minimize on-farm mortality. Pennsylvania has the second most dairy farms of any state in the US, with a wide range of herd management styles and a low rate of lactating cow mortality on farms when compared to other regions[13,16] and neighboring states.[9] The large diversity in herd management styles facilitates evaluation of the relationship between herd management system and mortality rate among herds with similar climatic and other environmental factors.

The objectives of our research are to investigate associations of mortality and early lactation culling with herd management system, as described by a survey of Pennsylvania dairy herds, and to evaluate the impact of sire selection on mortality rate.

Materials and Methods

A herd survey that fit on one double-sided page was provided to Dairy Herd Improvement (DHI) milk recording technicians in 2006 and 2007 in order to describe a herd's management style.[6] The herd survey was designed to ascertain the herd's housing system, bedding types, feeding system, pasture use for heifers, dry cows and lactating cows, and other farm characteristics. Five broad management systems were derived from the data: free-stall herds with complete confinement for lactating cows (37 herds), free-stall herds with some level of outdoor access for lactating cows (76 herds), tie-stall herds with complete confinement for lactating cows (52 herds), tie-stall herds that fed a total mixed ration (TMR) and with outdoor access for lactating cows (72 herds), and tie-stall herds that did not feed a TMR and with outdoor access for lactating cows (77 herds).

Herd management descriptions were available for 314 dairy herds that also had mortality rate information. There is variation among herds in the manner in which cow disposal codes (such as "died") are used.[7] Therefore, the proportion of cows culled or that died from 21 days before a cow's due date though 60 days-in-milk (DIM) was evaluated in addition to mortality rate as few cows are culled in early lactation due to the productive potential of the rest of the lactation unless there is a health problem.[4]

Mortality rate (and 60-day cull rate) was defined as the ratio of the number of lactating cows that died (or left the herd prior to 60 DIM) in a 12-month period to the average number of cows in the herd during the year. Since older cows have elevated mortality risk, the proportion of cows that died or were culled by 60 DIM were also evaluated separately for ≥ third lactation. Mortality and 60-day culling were evaluated with a statistical model that included the significant effects of herd management system, the proportion of mature cows in the herd (defined as ≥ six years of age and ≥ fifth lactation), the percentage of the herd that was Holstein, and a dummy variable to indicate heifers were recorded by DHI before their first calving. Herds not recording heifer data in DHI may have a lower apparent mortality rate because heifers that die during calving or before their first DHI test may not be captured by the DHI system.

A second series of evaluations[5] included an analysis of 20,438 individual cow mortality records (0 = survived or culled, 1 = died on-farm) in place of herd mortality rate. Cows were stratified into quartiles of sire predicted transmitting ability (PTA) for productive life. Mortality was evaluated with a logistic regression model and included the effects of herd management system, lactation number, bimonthly age at calving classes nested within lactation, sire PTA quartile, the interaction of sire PTA quartile and herd management system, and herd-calving-clusters.

Results and Discussion

Mortality and 60-day culling rate by herd management system

Marginal means of herd mortality rate and 60-day culling rate for herd management system are reported in Table 1. A four-fold increase in the rate of mortality occurred across all lactations and for ≥ third lactation when comparing the most favorable herd management system (tie-stalls with outdoor access and that did not feed TMR) to the least favorable system (complete confinement free-stalls). The 60-day cull rate results ranked herd management system in the same order as observed for mortality rate.

Herd management characteristics were associated with cow mortality rate following the National Animal Health Monitoring System (NAHMS) Dairy 2002 survey.[13] There is strong agreement when comparing their results to those reported in Table 1. Results were expressed as the proportion of herds with high (>6.25%), medium (2.5% to 6.25%), and low (<2.5%) mortality.[13] A

Table 1. Marginal means of mortality (%) and 60-day culling for herd management system*

	All lactations		≥3rd lactation	
Herd management system	**Mortality**	**60-day cull**	**Mortality**	**60-day cull**
Free-stall / complete confinement	8.3[a]	9.7[a]	12.4[a]	18.3[a]
Free-stall / outdoor access	5.4[b]	9.5[a]	9.1[ab]	16.6[a]
Tie-stall / complete confinement	3.9[c]	7.0[b]	7.0[bc]	14.0[ab]
Tie-stall / outdoor access / TMR	3.9[c]	6.9[b]	6.4[c]	11.6[bc]
Tie-stall / outdoor access / no TMR	2.0[d]	5.1[c]	3.1[d]	8.4[c]

*Dechow CD, Smith EA, Goodling RC. The effect of management system on mortality and other welfare indicators in Pennsylvania dairy herds. *Anim Welfare* 2011;20:145-158.

[a-d]Estimated marginal means in a column that do not share a common superscript differ significantly ($P < 0.05$).

significantly higher proportion of tie-stall or stanchion herds (34.1%) were in the low-mortality class than herds that did not house cows in tie-stalls (16.6%). Neither the Pennsylvania study[6] nor the NAHMS study[13] provides evidence of why mortality is lower in tie-stall systems. Other evidence suggests that lameness and foot disease is lower in tie-stalls than in free-stalls,[2,3] and herds with higher lameness were reported to have elevated mortality.[13]

Allowing lactating cows to access pasture was associated with a smaller proportion of herds with high mortality (21.9%) than not allowing pasture access (28.5%).[13] Other studies report similar results for pasture versus non-pasture systems. The mortality rate in pasture herds was reduced by 75% in comparison to non-grazing herds in Denmark.[1] The authors also reported that mortality rate declined as the number of hours on pasture increased among grazing herds, whereas allowing cows free access to barn and pasture was associated with increased mortality.

Feeding TMR was associated with an elevated risk of mortality in the NAHMS Dairy 2002 survey in both a univariate analysis and with a multivariable model that identified seven significant variables.[13] Feeding TMR was associated with the highest mortality rate class for 30% of herds, versus 17.5% for those herds that did not feed TMR. Herds that used forage tests and used milk urea nitrogen tests to balance rations also had higher mortality rates.

It is possible that TMR feeding is an indicator of an aggressive feeding system and, subsequently, higher rates of acidosis. High-mortality herds were previously reported to have a significantly higher incidence of fat-protein inversions.[4] Recent work[12] has demonstrated that cows with acidosis will preferentially select longer particle size forages if offered. A simple strategy to monitor whether the diet is providing enough effective fiber may be to provide free-choice dry hay separate from the TMR and adjust the TMR to increase fiber if cows consume hay aggressively.

Many other factors associated with intensive dairy production (using rBST; rigorous vaccination programs; restricted access to ponds, rivers and other waterways; feeding anionic salts; separating a calf from dam immediately after birth) were associated with higher mortality in the NAHMS Dairy 2002 survey.[13]

Mortality and sire selection

The heritability of mortality was reported to be only 1.3% in the US dairy cow population.[14] Nevertheless, genetic selection may provide an opportunity to develop cows suited to different herd management systems and help to reduce the level of mortality.

The proportion of cows that died within sire quartile for productive life are shown in Table 2 for the most favorable (tie-stalls with outdoor access and that did not feed TMR) and least favorable herd management system (complete confinement free-stalls). Mortality rate was reduced in both systems as sire PTA for productive life increased.

Genetic selection programs have historically placed a large emphasis on higher levels of milk yield. While this enhances the efficiency of dairy production, not all herd environments are suited to supporting the health of such cows and therefore elevates the risk of mortality. Results in Table 2 suggest that placing heavy emphasis on sire productive life may help to reduce cow mortality, which could be particularly important in intensive herd management systems.

Pennsylvania DHI records were stratified into classes of high and low mortality rate (rather than by herd management system) and into quartiles of sire PTA for functional traits and yield traits.[5] In addition to selecting for higher productive life, lower somatic cell scores, higher daughter pregnancy rate, and lower calving ease and stillbirth scores (high score is associated with more calving difficulties or stillbirths) were associated with favorable mortality and 60-day culling risk. Selecting for high milk and protein yield were associated with elevated 60-day culling risk, particularly among herds with high mortality and 60-day culling rates.

Table 2. Mortality risk by quartile of sire productive life*

	Productive life quartile			
Herd management system	**1 (low)**	**2**	**3**	**4 (high)**
Free-stall / complete confinement	$6.6^{a,x}$	$7.1^{a,x}$	$4.6^{b,x}$	$4.6^{b,x}$
Tie-stall / outdoor access / no TMR	$4.3^{a,x}$	$3.6^{ab,y}$	$1.7^{b,y}$	$1.8^{b,y}$

*Dechow CD, Goodling RC, Rhode SP. The effect of sire selection on cow mortality and early lactation culling in adverse and favorable cow survival environments. *Prev Vet Med* 2012;103:228-233.

[a,b]Values within rows not sharing a common superscript are significantly different ($P < 0.05$).

[x,y]Values within columns not sharing a common superscript are significantly different ($P < 0.05$).

A second strategy to develop cows suitable to intensive management systems may involve crossbreeding. Substantial reductions in mortality for first-lactation crossbred cows (≤2.0%) compared with mortality with first-lactation Holsteins (5.3%) were reported in large California herds.[11] Increased rates of survival resulted in higher lifetime production in crosses, despite lower per lactation yield.

Limitations and implications of the current study

A critical limitation to the study reported here is that the reasons cows die in one herd management system when compared to other systems remain unknown. This limits our ability to make firm recommendations about strategies to reduce cow mortality. For example, herds with more aggressive feeding systems (TMR, using forage and MUN tests to balance rations, feeding anionic salts) have been associated with higher rates of cow mortality. It is not clear whether it is the feeding system that results in elevated death rates, or if such feeding systems are adopted by herds that tend toward higher mortality for other reasons. There is also a growing body of evidence that pasturing dairy cows reduces the incidence of mortality. However, studies do not provide a clear understanding of the reasons (behavioral advantages, diet, foot health, lower milk yield, sunlight, etc.) pastured dairy cows have improved survival.

Despite these limitations, there are several important implications to herd management system research, particularly given recent interest in the development of programs to document and improve animal welfare. While it is not certain that aggressive feeding programs elevate cow mortality, for example, we can conclude that current ration balancing approaches do not improve cow health and welfare.

Tie-stalls create obvious behavioral limitations when coupled with a lack of outdoor access, which have made them an easy target of programs to improve animal welfare. In light of lower mortality and lameness in tie stall systems, it is unlikely that tie-stall restrictions have (beginning to be phased out in Scandinavian countries) or will achieve the intended aim of improving cow welfare. It is possible that eliminating or restricting the use of tie-stalls could actually degrade welfare if cows are shifted to herd management systems associated with higher mortality and lameness. It is also not certain that the behavioral environment of cow management systems would improve with restrictions to tie-stall systems. Frequent pen movements and less stable social structures create stress in loose housing systems.[15] These behavioral stressors could be as severe as those induced in tie-stall systems, but are less visually apparent.

Conclusion

Large changes intended to enhance financial and labor efficiencies have been implemented in order to facilitate the economic survival of dairy farms. Studies report that the more intense management systems that have been implemented to enhance economic efficiency are associated with elevated rates of mortality. This suggests that there may be an inherent conflict between economic efficiency and the well-being of the cow in intensive production systems. Further evaluation of feeding systems, pasturing strategies, housing strategies, and genetic selection strategies are warranted to reduce economic and cow welfare losses associated with elevated mortality rates.

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