ECONOMIC CONSEQUENCES IN THE VITAL 90™ DAYS

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WHAT IS THE VITAL 90™ DAYS AND WHAT IS IMPORTANT ABOUT IT FROM AN ECONOMIC PERSPECTIVE?

The Vital 90™ Days begins approximately 60 days prior to calving and continues through the first 30 days of lactation. During this time, dairy cows experience a series of biological and physiological transitions that are usually accompanied by large changes in feed intake, dramatic shifts in hormonal profiles, and major fluxes in hepatic demands and function. The resulting negative energy and negative protein balance as well as immune suppression often lead to a multitude of metabolic and infectious problems including, but not limited to, retained fetal membranes, ketosis, metritis, displaced abomasum and mastitis among others.

Cows that experience one or more metabolic or infectious challenges during the Vital 90 Days usually experience higher culling and mortality risks. The reason for the higher risk being associated with this periparturient time is multi-fold. First, due to a large decline in feed intake and the hepatic challenge of increased demand for gluconeogenesis, cows are more likely to experience metabolic stress in addition to infectious challenge. Second, a significant proportion of cows that experience an adverse health issue actually suffer more than one such event increasing the negative impact on performance and increasing the culling risk. Finally, cows that experience negative health consequences in early lactation often have carryover effects that impact future milk production, reproductive performance, and even future disease risk (Duffield et al., 2009; Overton et al., 2008; Santos et al., 2013; Wilson et al., 2004). As a consequence, the short term culling and mortality risk is higher and there is carryover impact on future culling risk.

In a similar manner, disease that occurs during The Vital 90 Days is also associated with significant milk production losses. As in the case of culling, milk production losses can be measured in terms of immediate impact and in long term impact. Certain diseases such as metritis (with or without retained fetal membranes) and mastitis that occur during the immediate post parturient period are often associated with potentially large levels of acute milk loss, but these disease events are also associated with longer term milk loss either via negative impacts to the lactation curve that are never fully recovered or via long term damage to milk secretory cells. Also, early lactation disease such as mastitis is expected to have a greater negative impact on milk production than a similar case that occurs later in lactation due to the lactational time at risk.

One of the challenges to understanding/estimating the economic impact of disease consequences during The Vital 90 Days is the apparent association between diseases. As shown in Figure 1, the appearance of one disease challenge is often associated with another downstream disease issue (Duffield et al., 2009; Godden et al., 2006; Huzzey et al., 2007; Kimura et al., 2002; Loeffler et al., 1999). For example, cows with hyperketonemia (BHBA > 1200 µmol/L) have a higher risk of experiencing a left displaced abomasum (LDA), but cows with hyperketonemia in week one postpartum have a 6.1X higher risk of experiencing an early lactation LDA as compared to cows developing hyperketonemia later (Duffield et al., 2009; McArt et al., 2012). This is not to say that one disease or issue causes another, but rather that there are often associations that exist such that when one condition is observed, there is a higher likelihood of seeing other related conditions. In general, cows that experience greater immune suppression during the periparturient period are more likely to experience retained fetal membranes, metritis, and mastitis; while cows that experience more severe negative energy balance are more likely to experience ketosis, displaced abomasum, and ovarian dysfunction.

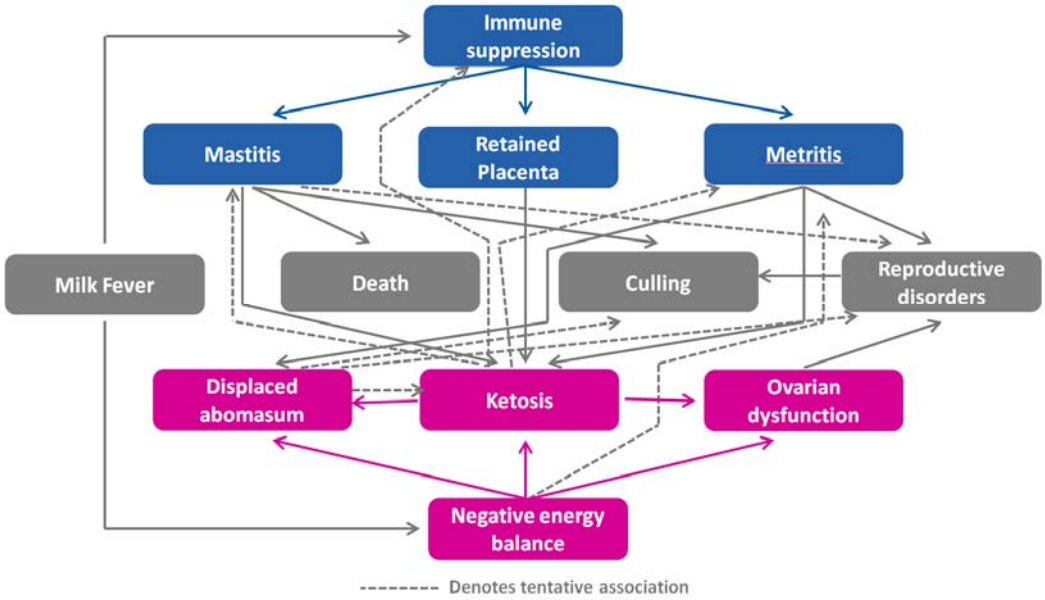

Figure 1. Demonstrated and tentative associations between various periparturient challenges in dairy cattle.

As a consequence of the multitude of negative impacts of metabolic and infectious challenges that occur during the Vital 90 Days, dairy producers and influencers typically spend considerable time, money and effort attempting to mitigate the negative impacts and consequences of these challenges. However, despite the high level of financial and management investment, few have carefully considered the full magnitude of cost incurred by each cow that calves. Elanco Knowledge Solutions, an analytics team within Elanco Animal Health, has developed a new tool to estimate and demonstrate the various costs of The Vital 90 Days at the farm level, and to present a new industry metric for evaluating transition dairy cow performance, The Vital 90 Days Cost per Calving.

WHAT IS THE ECONOMICS ASSESSMENT TOOL AND WHAT DOES IT DO?

The Economic Assessment Tool is part accounting tool and part economic model. It does not suggest or predict management needs but instead, tabulates all of the various costs currently being incurred during The Vital 90 Days other than routine feed costs or costs associated with milking during early lactation. The total cost estimate that is calculated by the Economic Assessment Tool is called The Vital 90 Days Cost per Calving.

This new metric, The Vital 90 Days Cost per Calving, is comprised of two major types of cost. The first cost for consideration is called the *Investment Cost* of the Vital 90 Days and is comprised of all of the vaccinations, therapeutics, nutraceuticals, feed additives, and management time and effort used by the dairy and its staff to mitigate health risks and to help increase the likelihood of a successful lactation. The tool allows each consultant to input the farm-specific protocols for each individual herd under consideration instead of relying on industry-wide estimates, and these inputs are stratified into first calving and second or greater calving to reflect potential management differences between animals calving for the first time and those returning to lactation. As mentioned previously, feed additives are considered in the Investment Costs but the base ration cost for each group is not considered.

The second source of costs in The Vital 90 Days is the *Consequence Cost.* Despite typical preventive efforts, 45-60% of cows typically experience one or more transition-related disorders (Ribeiro et al., 2013; Santos et al., 2010). *Consequence Cost* of disease refers to the total impact of disease occurring during this time and is subdivided into *Direct Disease Costs* and *Indirect Disease Costs.*

Direct Disease Costs include most of the commonly recognized costs associated with the impact of disease including diagnostics and therapeutics for clinical cases treated, the value of milk that must be discarded during treatment and any required withdrawal period, veterinary services, on-farm labor, and death losses that are directly associated with specific periparturient disease issues. Some people may refer to Direct Disease Costs as explicit costs since these often seem more tangible and typically occur at or very near to the time of disease diagnosis.

Indirect Disease Costs, however, are usually more implicit in nature and often represent the “lost opportunity cost” of disease. The contributors to *Indirect Disease Costs* include any predicted future milk production losses, future culling losses, on-going diagnostic or monitoring costs, future reproductive losses, and in many cases, other diseases that are attributable to the initial disease in question. By summing the Direct Disease Costs and the Indirect Disease Costs, the total Consequence Cost is determined.

When attempting to calculate the impact (and therefore, the cost) of a specific disease on the risk of other downstream diseases, the attributable risk and attributable cases must be estimated. Attributable risk is an epidemiological term that describes the

difference in disease risk between an exposed population and an unexposed population. In order to calculate the attributable risk, the relative risk (RR) for the exposed population as compared to the non-exposed population should be adapted from the veterinary literature. For example, if a herd has a recorded incidence of 40% hyperketonemia in early lactation and cows with hyperketonemia have a RR of 8 for LDA, then cows with hyperketonemia are 8 times more likely to develop an LDA as compared to their non-affected herd mates. If the underlying risk of LDA for the herd as a whole is 3%, the risk of LDA in unaffected cows is ~0.8% and in hyperketonemic cows, the risk is ~6.3%. Consequently, the attributable risk of LDA given hyperketonemia is ~5.5%. Thus, ~88% of the total LDA cases in the herd can be attributed to hyperketonemia. The remaining 12% of the total cases (0.8% incidence in the "normal" cows) is found in cows that never experienced primary, early lactation hyperketonemia and these cases occurred due to other unexplained reasons.

In the estimation of the *Indirect Disease Cost* of a specific disease, extreme care must be taken to avoid double or triple counting of costs. In the Economic Assessment Tool, two disease cost estimates are given for common transition issues that occur very early in lactation and that are linked to other costly outcomes further downstream such as clinical hypocalcemia, retained fetal membranes, hyperketonemia, and metritis. First, the *Component Cost* of a disease is reported. This cost estimate includes those *Direct* and *Indirect Disease Costs* that are directly attributable to the disease in question without consideration of further downstream impacts on other diseases. By summing all of the disease costs *not attributable to other diseases*, the Component Cost can be estimated with minimal risk of double counting disease costs.

Second, the *Total Cost* of a disease is also reported and this cost estimate includes the Component Cost and any additional *Direct* and *Indirect Disease Costs* incurred as the result of development of other disease issues that are predicted to result as a consequence of having the original issue in question. If the Total Cost of each disease reported were added together, a *greatly inflated disease cost estimate would be created*. Hence, the Total Cost of a disease is only applicable when discussing the potential impact of a product or management change on one very specific disease without regard to its carry over impact on any other disease.

For example, in the case of hyperketonemia, there is a strong association between the presence of elevated ketones in the blood in the early post parturient time period and a multitude of adverse health events including, but not limited to, an increased risk of culling, death, metritis, displaced abomasa, and future reproductive challenges. If the Total Cost of hyperketonemia was added to the Total Cost of metritis and the Total Cost of displaced abomasa, we would grossly overestimate the cost of hyperketonemia and the predicted number of cases of metritis and displaced abomasums would greatly exceed the herd's actual number of cases. However, if we add the component costs of each disease, the grand total will more accurately reflect the total impact on the herd.

The Economic Assessment Tool adds the total investment cost of the far off, close up, and maternity/fresh cows to the total consequence cost (direct and indirect disease costs) and reports The Vital 90 Days Cost per Calving by parity. To correctly tabulate all of the Investment and Consequence Costs, a number of inputs must be made carefully and correctly. These inputs consist of the following sections:

1. General herd parameters - The first set of inputs involves whole farm inputs such as milk price, labor cost, replacement heifer cost, how waste milk is utilized, culling risk, etc. These inputs serve as the basis for the calculation of many other inputs and outputs such as the value of marginal milk and the cost of discarded milk during treatment.

2. Preventive protocols - In the Economic Assessment Tool, there is a detailed section for customizing each of the routine preventive protocols that occur during the far off, close up and calving/fresh periods. Expected costs, based on currently available market prices, are already embedded in the tool but can and should be customized for each herd.

3. Disease incidence - In order to correctly tabulate disease costs, the current incidence of the various common transition disorders must be input by parity group. Unfortunately, many dairies struggle with this area. Occasionally, herds may record disease issues in paper form but fail to enter the information in the computerized on-farm record system. Unfortunately, a far more common problem is simply a failure to utilize consistent disease definitions along with a failure to consistently record the occurrence of disease. Without proper disease information, the Economic Assessment Tool will vastly underestimate The Vital 90 Days Cost per Calving.

4. Treatment protocols - Each herd should have a standardized approach to treatment of common transition disorders such as milk fever, ketosis, metritis, mastitis, etc. The Economic Assessment Tool has a very detailed data input section that facilitates input and customization of the standard treatment protocols for each disease issue by parity group. As with the preventive protocol section, most of the commonly used pharmaceutical agents are already present in the tool but may be customized in terms of dose, duration, withdrawal and cost in order to more carefully and accurately reflect the farm's current protocols.

When attempting to understand any biological or economic system, the results and conclusions reached from analysis are greatly influenced by the accuracy and completeness of the inputs and other contributing factors. Similarly, the utility of the Economic Assessment Tool will not be optimized and its full value not realized if the inputs in the tool are incomplete or inaccurate. Hence, careful consideration of the herd's current general parameters, precise description of its preventive and treatment protocols, and accurate calculation of true disease incidence is critical. During development and early field use of this tool, the single largest bottleneck to capitalization of the value of the Economic Assessment Tool is the inconsistencies or total failure to correctly and consistently define and record disease occurrence on

dairies. When disease information is not captured, the tool will generate an estimate of cost that is lower than reality. For more information on the topic of disease recording, please see the companion paper in these proceedings titled “Disease Records for Impactful Decisions During The Vital 90™ Days”.

If inputs have been carefully and accurately made into the Economic Assessment Tool, the output will represent the estimated cost of transitioning a cow through the Vital 90™ Days and will allow the user to now ask pertinent management questions such as 1) “What is the estimated economic impact of adding input X in the Vital 90 Day period?”; 2)“If the incidence of disease Y can be reduced by 30%, how does this impact my herd?”; 3) “Given the current level of inputs and disease incidence in my herd, what are the biggest opportunities to improve my profitability?”; 4) “How does a change in replacement heifer cost or market cow value impact the Cost per Calving?”

Dairy managers and consultants need better decision making tools. Owners and managers are asked to consider using new or improved products on a routine basis. However, identifying the cost/benefit or return on investment for these opportunities can be difficult. One approach to these types of decisions is to assess the overall investment strategy and disease consequence costs of a proposed change. The Economic Assessment Tool is a new means to help answer these questions and to help better understand the total investment and consequence costs associated with freshening a dairy cow.

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