Evaluation of Negative Energy Balance in Dairy Cows in Qom Province, and its Relationship with Periparturient Diseases

Mohammad Reza Mohebbi1*, Samad Lotfollahzadeh1 and Majid Mohammad Sadegh2

1Faculty of Veterinary Medicine, Department of Internal Medicine, University of Tehran, Iran
2Assistant professor of theriogenology, Islamic Azad University, Iran

Submission: February 01, 2019; Published: February 21, 2019

*Corresponding author: Mohammad Reza Mohebbi, Department of Internal Medicine, Faculty of Veterinary Medicine, University of Tehran, Qareeb Street, Azadi Avenue, Postal Code:1419963111, P.O.Box : 14155-6453, Tehran, Iran

Abstract

Objective: The aim of this study was to evaluate the correlation between negative energy balance (NEB) and periparturient diseases and to introduce blood BHBA and glucose values as instruments to detect cows with NEB to prevent its harmful effects on immunity and the incidence of periparturient.

Material and Methods: 207 fresh Holstein cows were being investigated over the 2-4 weeks after parturition. BHBA and glucose concentrations were determined, using portable strip test by Optimum Xceed® (Ireland MediSense®Optium), data were evaluated by statistical programs and the results were recorded.

Results: The incidence of NEB in central Iran (with threshold of 1 mmol/l for serum BHBA values) was 16.3 % that is in range of other reports. Although the incidence of preparturient diseases other than RP was lower than other studies. Serum BHBA values in cows with periparturient diseases were significantly higher than cows with no periparturient diseases. There was no significant correlation between milk production and the values of serum BHBA (P<0/05). Days open and parity were significantly higher in cows with NEB in comparison with cows with no NEB. There was no significant correlation between serum glucose values and periparturient diseases, parity, milk production, and days open (p>0/05)

Keywords: Negative energy balance; Glucose; BHBA; Periparturient diseases

Introduction

Negative energy balance (NEB) is a circumstance occurring in high milk producing fresh cows. It defined as an imbalance between dry matter intake and production needs [1]. After parturition, cows face a sharp increase in production and loss of appetite due to calving stress and high levels of diet change [1]. NEB can be detected by relatively high concentrations of the ketone bodies acetoacetate, β-hydroxybutyrate (BHBA) and acetone, and a simultaneous low concentration of glucose in the blood [2-4]. The cows decline to mobilization of adipose reserves, and they often lose 60% or more of their body fat in the first weeks of calving [5,6]. Failure of hepatic gluconeogenesis to compensate energy requirements for milk production and body needs, may be one cause of NEB [7].

The effects of NEB on reproductive system was demonstrated [8]. The period of NAB is accompanied with immunosuppression, periparturient diseases and increased times to first ovulation and first service [9]. The objective of this study was to evaluate the correlation between NEB and periparturient accidents in dairy cows of Qum province and subsequently to assay the reliability of blood BHBA and glucose values to prevent NEB disorders.

Materials and Methods

Animal and farm management

Two hundred-seven fresh Holstein cows were being investigated after parturition in dairy farms of central Iran.

They were selected randomly based on their calving date during September 2010 to May 2011. They were milked twice daily and milk yield was recorded once a week. All information such as parity, date of pregnancy, service to pregnancy ratio, last days open, milk production, etc. were recorded in individual forms for each cow.

Sampling and sample analysis

Blood samples were collected from all cows in 1-2 weeks after parturition, at least 4 hours after feeding for minimizing
the effect of feeding on the results. BHBA and glucose concentrations were determined on-farm, using portable strip test by Optium Xceed® (Ireland MediSense® Optium), according to the instruction of the producing company. Sensitivity and specificity of the Optium Xceed® has been evaluated 100% in one study [10], 90% and 98% respectively in another study [11].

Statistical analysis

In this study, SPSS software was used for statistical analysis of the data. One Sample Kolmograv-Smirnov test is used to determine the normal distribution of the BHBA and glucose values of blood serum. Kruskal-Wallis and One-way ANOVA tests were used to evaluate the difference between BHBA and glucose in various groups of sick and healthy cows, respectively. The Chi-square test was used to evaluate the distribution of the cows in two groups of normal and high BHBA and glucose levels of the blood samples. Pearson test was also used to evaluate correlation between days open, parity and milk production with BHBA and glucose levels of the blood samples. The two tails level of statistical significance was present at p≤ 0.05.

**Results**

Averages of milk production, parity, weight of calves at birth, days open, BHBA, and glucose values of blood serum were

|                      | No diseases | RP | Dystocia | RP+ milk fever | Fatty liver | Downer cow syndrome | Mastitis | LDA | RP+ metritis | Ketosis | Laminitis | Total |
|----------------------|-------------|----|----------|----------------|-------------|---------------------|----------|-----|--------------|---------|-----------|-------|
| BHBA values          | 0.57        | 1.37 | 2.4       | 1.9            | 0.5         | 0.5                 | 1.4      | 1   | 0.5          | 1.5     | 0.5       | 0.75  |
| Glucose values       | 77.41       | 59.33 | 71.00     | 54.24          | 69.80       | 57.18               | 58.34    | 38.77 | 52.55        | 46.11   | 73.12     | 63    |

**Table 1:** average values of blood serum BHBA and glucose in healthy cows and cows with periparturient diseases.

**Table 2:** comparison between healthy cows and cows with different periparturient diseases based on the BHBA threshold.

| Periparturient diseases | BHBA<1 (%) | BHBA>1 (%) | Total (%) |
|-------------------------|------------|------------|-----------|
| No diseases             | 76.4       | 7.2        | 83.7      |
| RP                      | 2.4        | 4.3        | 6.7       |
| Dystocia                | 1.9        | 0.5        | 2.4       |
| RP+ milk fever          | 0.9        | 1          | 1.9       |
| Fatty liver             | 0          | 0.5        | 0.5       |
| Downer cow syndrome     | 0          | 0.5        | 0.5       |
| Mastitis                | 1.4        | 0          | 1.4       |
| LDA                     | 0          | 1          | 1         |
| RP+ metritis            | 0          | 0.5        | 0.5       |
| Ketosis                 | 0.5        | 0.5        | 1         |
| Laminitis               | 0          | 0.5        | 0.5       |
| Total                   | 83.7       | 16.3       | 100       |

In this study threshold of 1 mmol/l for serum BHBA is indicated as a cut point of NEB. Healthy cows with no periparturient diseases and cows with periparturient diseases were compared based on the standard threshold of BHBA (1 mmol/l) (24 the)
and the K-square test showed that the cows with periparturient diseases significantly have the BHBA values higher than 1 mmol/l (p<0.05) (Table 2). Totally 57.17 % of cows with NEB, involved with periparturient diseases compared with 6.8 % of cows with no NEB. Comparison between cows with no NEB and cows with NEB, about days open is showed in Table 3 and cows with NEB significantly had the higher days open (P<0.5). Also, the incidence of NEB was compared with number of parity and the group with NEB had significantly more parity (3.38 parity) than group with no NEB (2.19 parity) (Table 4).

**Table 3:** comparison between days open in cows with lower and higher than 1 mmol/l serum BHBA.

| Groups                     | Number of cows | Percentage | Days Open Mean |
|----------------------------|----------------|------------|----------------|
| BHBA>1 (cows with NEB)     | 29             | 20.7       | 131.5          |
| BHBA<1 (cows with no NEB)  | 111            | 79.3       | 93.19          |
| total                      | 140            | 100        | 101.1          |

**Table 4:** comparison between parity in cows with lower and higher than 1 mmol/l serum BHBA.

| Groups                     | Number of cows | Percentage | Parity Mean |
|----------------------------|----------------|------------|-------------|
| BHBA>1 (cows with NEB)     | 34             | 16         | 3.38        |
| BHBA<1 (cows with no NEB)  | 174            | 83.7       | 2.19        |
| Total                      | 208            | 100        | 2.38        |

**Discussion**

Duffield introduced two tests to investigate NEB, pre-calving NEFA and post-calving BHBA blood values [12]. In this study, measurement of BHBA and glucose blood values in fresh cows is used to evaluate NEB. Kocako [13] showed the rate of periparturient diseases in fresh cows as: milk fever 7.2 %, DA 3.3 %, ketosis 3.7 %, and RP 9 % [13]. In the current study, incidence of periparturient diseases was recorded as: milk fever 1.4 %, DA 1.4 %, clinical ketosis 1 %, RP 9.5 %, septic metritis 1 %, and mastitis 1.4 %. All diseases other than RP had the lower incidence in comparison with other studies; however, in one study Tai-Young [14] recorded the incidence of RP 14 % which is higher than current study. The prevalence of subclinical ketosis was reported in wide ranges. Prevalence for increase in BHBA in fresh cows has ranged from 8.9 to 34 % in different studies. In this study, 16.3 % of sampled fresh cows had the BHBA higher than 1mmol/l (Table 2).

In most studies, NEB has most correlation with DA [15]. In current study there was a significant relationship between NEB and the incidence of DA, RP, and metritis. It has been demonstrated that the severity and duration of NEB have the positive correlation with the time of first ovulation after calving [16,17]. And, in another study animals with BHBA concentrations ≥10mg/dl had a 13 % decrease in risk of pregnancy [18]. In this study, the correlation between days open and serum BHBA values was calculated. Statistical analysis showed that mean days open in group of cows with BHBA >1 mmol/l is 13 1.5 days and in a group of cows with BHBA <1 mmol/l is 93/19 mmol/l (p<0.05). In two study greater serum BHBA post-calving were associated with less milk yield, greater milk fat percentage, and less milk protein percentage [18,19]. But Kaupe [20] indicated that there is a significant positive relationship between BHBA concentration and milk production while the cows with increased BHBA significantly have the higher milk production that can be result in being in the higher risk for ketosis in this group [20].

There was no significant correlation between milk production and the values of serum BHBA (P<0.05). Parity 1 cows mobilized fewer fatty reserves than parity 2 and 3 cows [21]. But in another study, there was no meaningful correlation between parity and ketosis [13]. In current study mean parity of cows with BHBA>1 mmol/l was 3.38 and of cows with BHBA<1 mmol/l was 2.19 (p<0.05). Several studies reported that concentrations of plasma glucose and insulin in cows with fatty liver disease were not lower [22,23]. In another study IGF-I (PZ0.001) and glucose (PZ0.001) concentrations, were lower in Sever NEB in comparison with Mild NEB cows [24-26]. In this study mean glucose concentration in cows with BHBA>1 and cows with BHBA<1 was 42.5±4.72 mg/dl and 69.46±3.76 mg/dl respectively (p<0.05). But There was no significant correlation between serum glucose values and periparturient diseases, parity, milk production, and days open (p>0.05).

**Conclusion**

Based on the findings of this study, measurement of blood BHBA and glucose values are reliable to detect NEB and prevention of periparturient diseases with more emphasis on BHBA. The authors declare that this study is done in the limited geographic area and in limited cow sample size and it needs to be done in larger population considering other involving factors such as dry mater intake before and after parturition.

**Acknowledgement**

The authors express their grateful thanks to the Islamic Azad University, Garmshar branch for technical supports.

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