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Review Article

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Cows Postpartum Polymorbid Pathology

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Abstract

The postpartum period is one of the most important moments in a female's life. During this period caused by pregnancy and childbirth involutional changes in the reproductive system and the body as a whole occurs, which plays a crucial role in restoring reproductive function and milk productivity of cows. In this regard, the puerperium is the basis for structural and functional disorders in individual organs and systems, the disposition for the development of pathological processes and the negative impact on the reproduction of the herd, impaired fertility, calf yield and milk productivity. Diseases during the postpartum period in cows have species and age polymorbidity, specific in highly productive animals and first-borns and are especially common in hypovitaminosis and trace elements. Their occurrence is associated with unsatisfactory conditions for keeping and feeding cattle, mainly in the autumn-winter and winter-spring periods of the year, especially during the stable keeping of cows. The pathogenesis is based on metabolic disorders and endocrine dysfunctions with a decrease in the body's resistance, which is complicated by the action of adverse environmental factors. Puerperal pathologies are quite common and described in the literature as individual diseases, but limited – by their combination (co-, poly- and multimorbidity, multiorgan failure, multiple, complex, combined, and concomitant pathology, associated and multifactorial diseases or polypathy). Options of combining postpartum pathologies are diverse with the involvement of metro- and ovariopathies, udder diseases, fallopian tubes and metabolism in the form of inflammatory processes and dysfunctions. The hypogonadism development on the background of chronic metritis, or endometritis complicated by ovarian dysfunction, or subclinical chronic endometritis with hypoluteolysis, salpingo-oophoritis and salpingitis is widespread. Postpartum inflammatory processes in the genitals are the cause of prolonged symptomatic infertility and are often registered in the form of acute endometritis in combination with inflammatory processes of other genitals. For example, inflammation of the endometrium in many cases is accompanied by inflammation of the mucous membrane of other parts of the genitals – cervicitis, vaginitis, vestibulitis. Quite often the simultaneous course of inflammatory processes in the genitals and udder of cows, as well as pathologies of the uterus and ovaries are registered. Thus, one of the most common combined pathologies of the postpartum period in cows is acute subinvolution of the uterus with acute metritis. As a result, it should be noted that in the case of organ pathology, a combination in the form of hypogonadism-metritis, hypocalcemia-metritis, hypoluteolysis-metritis, retained placenta-metritis, ketosis-hypoluteolysis, ketosis-metritis, mastitis-metritis and uterine subinvolution-metritis, and of multiorgans – vaginitis-vestibulitis-metritis-subinvolution of the uterus-cervicitis, vaginitis-metritis-cervicitis, hypocalcemia-ketosis-metritis, hypoluteolysis-ketosis-metritis, hypoluteolysis-metritis-salpingitis-salpingo-oophoritis, retained placenta-mastitis-metritis, ketosis-mastitis-metritis.

KEYWORDS
Cows, Postpartum, Polymorbid Pathology

Introduction

The postpartum period is one of the most important moments in a female's life, during this time there are involutional changes caused by pregnancy and childbirth in the reproductive system and the body as a whole, which plays a crucial role in restoring reproductive function and milk productivity of cows (Fagan and Roche, 1986; Short *et al*., 1990; Opsomer *et al*., 1996; Gryshko, 2003; Koshovyj, 2004; Stravs'kyj and Sergejev, 2018; Vel'bivec' *et al*., 2018; Carvalho *et al*., 2019; Goto *et al*., 2019; Stephen *et al*., 2019; Davydenkova, 2020). In this regard, the puerperium is the basis for structural and functional disorders in individual organs and systems, ie the prerequisites for the development of pathological processes. The pathogenesis of the latter is complicated by the action of adverse environmental factors (Peters, 1984; Grant and Albright, 1995; Haruta *et al*., 1997; Krajevs'kyj, 2005; Montiel and Ahuja, 2005; Homyn, 2007; Gaafar *et al*., 2010; LeBlanc, 2012; Crowe *et al*., 2015). At the same time there is a combination of two or more pathologies at one patient. Such conditions are called co-, poly- and multimorbidity, multiorgan failure, multiple, complex, combined, and concomitant pathology, or associated and multifactorial diseases or polypathy. These are several diseases that have a simultaneous course and a common or similar etiology and interdependent pathogenetic links, symptoms and syndromes (Bouchard, 1890; Feinstein, 1970; Van den Akker *et al*., 1996; Vjortkin *et al*., 2011; Meghani *et al*., 2013; Zhu-

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ravlev and Thorikova, 2013; Nurgazizova, 2014; Sharabchiev *et al*., 2014; Gudkov and Konovalov, 2015; Ramond-Roquin *et al*., 2016; Cassell *et al*., 2018; Voronin *et al*., 2018; Willadsen *et al*., 2018). In postpartum pathology, there is species and age polymorbidity, more often they occur in highly productive cows (Staples *et al*., 1990; Lucy, 2001; Dobson *et al*., 2007; Jul'met'eva *et al*., 2011; Galvão, 2018; Sakhniuk *et al*., 2018; Sheldon and Owens, 2018; Zaharovskij, 2018; Zhubanova and Sarsenbaeva, 2020) and firstborn (Bajmishev and Perfilov, 2010; Beloborodenko, 2012; Tresnyc'ka, 2006; Revunec', 2016; Skorikov *et al*., 2017; Golodjaeva *et al*., 2020). Clear polymorbidity is manifested by hypovitaminosis and trace elements. Vitamin deficiency in animals is observed mainly in the form of poly- rather than monohypovitaminosis. The same can be said about trace elements (Kabysh, 1995; Smith and Akinbamijo, 2000; Kondrahin, 2005; Kurtjak, 2006; Ceylan *et al*., 2008; Nikaidou *et al*., 2008; Abramov and Goridovec, 2010; Levchenko, 2012; Savinova *et al*., 2015; Omur *et al*., 2016; Ojha *et al*., 2018). Polymorbid postpartum pathology in cows covers a significant part of the herd, causing impaired reproduction, prolonged infertility, reduced calf yield and milk productivity (Haruta *et al*., 1997; Koshovyj, 2004; Krajevs'kyj, 2006; Homyn, 2007; Gaafar *et al*., 2010; Vlasenko, 2010; Fedorenko *et al*., 2012; Toni *et al*., 2015; Vel'bivec' *et al*., 2018; Venjakob *et al*., 2018; Carvalho *et al*., 2019).

Multiorgan obstetric diseases of cattle

The duration and rate of puerperium depend on several reasons: general condition, age of the mother, the peculiarities of pregnancy and childbirth. In multiple pregnancies, large fetuses, and weakness of labor, forced and rough extraction of the fetus, as well as in weakened animals, involutionary processes slow down. The latter have a much faster course in animals, which are given active exercise from 3-4 days after birth. Exercise activates metabolic processes in the body and increases neuromuscular tone of the body and uterus (Leslie, 1983; Zain *et al*., 1995; Koshovyj, 2004; Ivashkevich, 2015; Elmetwally, 2018; Miljutina and Tkachev, 2018; Braga Paiano *et al*., 2019).

The normal course of the postpartum period is possible only with a sufficient level of feeding on energy levels, digestible protein, sugars, vitamins, macro- and micronutrients, not only after childbirth, but also during pregnancy. (Butler and Smith, 1989; Dann *et al*., 1999; Roche *et al*., 2000; Pradhan and Nakagoshi, 2008; Truhachev and Nikitin, 2013; Bisinotto *et al*., 2018; Elmetwally, 2018; Michael *et al*., 2019).

There is evidence that insufficient carotene content in the blood of cows in the dry and postpartum periods significantly contributes to disorders of contractile function of the myometrium, delayed involution of the genitals and leads to inflammatory processes in the uterus (Kuz'mich, 2000). The relationship between the level of vitamin A and beta-carotene during the postpartum period and fertility parameters in cows is discussed in the works of other authors (Akordor *et al*., 1986; Wang *et al*., 1987; Graves–Hoagland *et al*., 1988; Akar and Gaziqlu, 2006; Gnojevyj, 2006; Dmitrieva, 2012; Halik *et al*., 2016; Madureira *et al*., 2016; Plemjashov *et al*., 2016; Darmenova *et al*., 2017; Kuz'minova *et al*., 2017). Vitamin A is important for the restoration and protection of epithelial tissues of the mucous membranes of the reproductive organs and excretory ducts of the glands. Therefore, morphological and functional damage due to vitamin A deficiency occurs primarily in those organs where the main structural unit is the epithelial secretory cell. The influence of vitamin A on the structure and function of the pituitary gland, thyroid and adrenal glands, ovaries and uterus of cows and heifers is quite fully covered (Koshovyj *et al*., 2004; Skliarov *et al*., 2020). According to Fedorenko *et al*. (2012) and Besedovs'kyj *et al*. (2012) such changes are a component of the postpartum hypogonadism pathogenesis and hypoluteolysis.

Pathologies of the postpartum period in cows occur in the winter-spring period of the year with tethered animals, and their immediate cause is poor feeding and irregular exercise (Huranov, 2015; Novikova and Konopel'cev, 2017; Vel'bivec' *et al*., 2018; Zhukov, 2018; Murtuzov, 2019; Beloborodenko *et al*., 2020). In contrast, in case of careless keeping and invariance of the feeding ration, the seasonal dynamics of postpartum diseases in cows were not detected (Korejba *et al*., 2015). Ordin and Plahotnjuk (2017) noted that poor feeding and improper maintenance of cows, lack of exercise lead to metabolic disorders and endocrine dysfunction, which in turn leads to a decrease in the body's resistance to various diseases with subsequent disruption of the placental complex, the likelihood of time of childbirth, subinvolution of the genitals and metritis in the postpartum period. According to them, the pathogenesis of manure retention, subinvolution and postpartum metritis is associated with disorders of steroidogenesis in cows. A characteristic pathogenetic factor is ovarian and placental dysfunction in dry cows with a decrease in progesterone-estradiol, which occurs due to a decrease in progesterone and an increase in estradiol in plasma. At the time of birth, progesterone-estradiol ratio in cows with delayed litter increases to 2.3:1 compared to healthy animals, which leads to inhibition of contractile function of uterine muscles, its atony and causes retention of manure (Ordin and Plahotnjuk, 2017).

In Murtuzov's research (2019) the age dependence of emergence of postpartum pathologies is revealed. Thus, among three-year-old cows during the first lactation, the incidence of metritis was 4.7%, mastitis – 3.1%, manure retention – 0.7%, hypocalcemia – 0.3%; among four-year-old cows during the second lactation 5.1% fell ill with metritis, 3.5% with mastitis, 1.6% with manure retention, and 0.4% with hypocalcemia; among five-year-old cows during the third lactation were registered: metritis – 6.3%, mastitis – 5.8%, manure retention – 2.3%, hypocalcemia – 0.5%; among six-year-old cows during the fourth lactation were diagnosed with: metritis – in 8.2%, mastitis – in 6.2%, manure retention – in 2.6%, hypocalcemia – in 0.7%; among seven-year-old cows during the fifth lactation the incidence was at the level of: metritis – 9.0%, mastitis – 7.2%, manure retention – 2.7%, hypocalcemia – 1.5%; among cows aged 8 years and older with 6 or more lactations fell ill: metritis – 10.7%, mastitis – 8.9%, manure retention – 3.4%, hypocalcemia – 1.7%.

In general, of the total number of examined animals, 7.5% of cows had metritis, 5.8% had mastitis, 2.2% had manure retention, and 0.9% had hypocalcemia. The author concludes that with the increasing age of cows and the number of lactations, their incidence of postpartum pathology increases.

Korea *et al*. (2015) based on the results of obstetric examination analyzed the prevalence of obstetric pathology in cows in the autumn-winter period. Postpartum pathology was detected in 20.6% of the total number of calved animals in the form of postpartum uterine subinvolution, hypocalcemia, endometritis, and vulvo-vaginitis (Korejba *et al*., 2015).

Postpartum inflammatory processes in the genitals are a common cause of prolonged symptomatic infertility, which accounts for 10 to 72% of the entire dairy herd of cows and are often registered in the form of acute endometritis in combination with inflammatory processes of other genitals (Homyn, 2007; Batrakov *et al*., 2013; Medvedev *et al*., 2013).

Today there is a lot of information about individual diseases of the postpartum period and limited – about their combination as a multiorgan pathology (Kolesnik, 2015; Semivolos and Zem-

ljankin, 2016; Zubkov and Skliarov, 2017; Sakhniuk *et al*., 2018; Venjakob *et al*., 2018; Goto *et al*., 2019). It is established that among the diseases of the postpartum period the most common are ketosis, hypoluteolysis, hypogonadism, subinvolution of the uterus, hypocalcemia, manure retention and metritis. These pathologies have the greatest impact on the further course of lactation and may generally call into question the further productive use of animals. Thus, in dairy farms, such pathologies as postpartum subinvolution of the uterus, postpartum endometritis and mastitis are registered in 60-80% of animals. Inferiority of changes occurring in the genitals of females in the postpartum period is a major link in the pathogenesis of symptomatic infertility and subsequently leads to infertility in cows (Zvjerjeva *et al*., 2000; Sheldon *et al*., 2006; Homyn, 2007; Fedorenko *et al*., 2012; Batrakov *et al*., 2013; Plugatyr'ov and Dovgopol, 2013; Toni *et al*., 2015; Ordin and Plahotnjuk, 2017; Davydenkova, 2020; Cattaneo *et al*., 2020).

In general, infertility in cows associated with obstetric and gynecological diseases depends on 18.5-38.1% of endometritis, 17.9-36.2% – on uterine subinvolution, 20.0-27.5% – from ovarian hypofunction, by 12.0-18.1% – from the persistence of corpora lutea in the ovary, by 1.7-2.4% – from ovarian cysts (Kuz'mich, 2000). Kalynovs'kyj and Zarembljuk (2014) point out that in the pathogenesis of combined pathologies an important link is the common blood supply and functional unity of organs, which under the influence of various factors disrupts their homeostasis. In most cases, this condition occurs after calving, in insemination of cows and various mechanical manipulations in the genitals, poor feeding, hypodynamics, especially during pregnancy and after calving.

Pathology of the postpartum period in cows is widespread and is more than 30%. Among the pathology of puerperium there is subinvolution of the uterus, which occurs against the background of even a minor metabolic disorder and abnormal birth (Homyn, 2007; Medvedev *et al*., 2013; Korejba *et al*., 2015).

The results of obstetric and gynecological medical examinations of cows often indicate the simultaneous course of inflammatory processes in the genitals and udder of cows (Hinkevich, 1973; Poljancev and Sinjavin, 1985; Huszenicza *et al*., 2005; Hudson *et al*., 2012; Boujenane *et al*., 2015; Korejba *et al*., 2015; Semina *et al*., 2019; Sirotinina, 2019). Thus, Vel'bivec' *et al*. (2018) found that, for example, inflammation of the endometrium in many cases is accompanied by inflammation of the mucous membrane of other parts of the genitalia – cervicitis, vaginitis, vestibulitis. And in his study, LeBlanc (2012) studied the combination of endometritis-cervicitis-vaginitis. The authors report that approximately 1 month after calving, the incidence of metritis is usually 10-20%, vaginitis – 5-15%, cervicitis – 15-40%, and another 1-2 months after calving subclinical endometritis – 10-30%. In total, 35-50% of cows show at least one form of pathological inflammation of the reproductive tract between 3 and 7 weeks after birth.

Quite often in the postpartum period combined pathologies of the uterus and ovaries are registered (Martins *et al*., 2013; Pothmann *et al*., 2015; Semivolos and Zemljankin, 2016; Salehi *et al*., 2017; Zhukov, 2018; Mohammed *et al*., 2019). Thus, one of the most common combined pathologies of the postpartum period in cows is acute subinvolution of the uterus with acute metritis (Avdeenko *et al*., 2015; Krajevs'kyj and Seredzhymova, 2018; Zhukov, 2018). Manure retention with the subsequent development of postpartum or chronic endometritis is widespread (Eremin and Eremina, 2006; Kaczmarowski *et al*., 2006; Topurija and Eskazina, 2012; Buso *et al*., 2018; Golodjaeva *et al*., 2020; Cattaneo *et al*., 2020), as well as the combination of subinvolution of the uterus with metritis (Tresnickij *et al*., 2018). In particular Vel'bivec' *et al*. (2018) who reported that diorgan pathology was diagnosed in 74.2% of cows.

Fedorenko *et al*. (2012), Gorpinchenko *et al*. (2016) and Semivolos and Zemljankin (2016) distinguished diorgan pathology in the form of hypogonadism on the background of chronic metritis, which is registered in 10-25% of infertile cows.

According to some authors, the most common pathology of the postpartum period in cows is endometritis, which is complicated by ovarian dysfunction – in particular their hypofunction (Nakao *et al*., 1992; Truhachev and Nikitin, 2013; Dovgopol and Panasova, 2020). Kalynovs'kyj *et al*. (2013) added that the course of subclinical chronic endometritis is complicated by hypoluteolysis, salpingo-oophoritis and salpingitis.

In a study on postpartum cows, Zubkov and Skliarov (2017) recorded 79% of cows with obstetric pathologies, including patients with ketosis 8%, endometritis –13%, hypoluteolysis – 12% and combined diseases: ketosis-endometritis – 19%, ketosis-hypoluteolysis – 10%, endometritis-hypoluteolysis – 10% and ketosis-endometritis-hypoluteolysis – 7%. Thus, of the total herd of cows, only 21% of the animals were clinically healthy, 8% had ketosis, 12% had hypoluteolysis, and 13% had endometritis. Diagnosis of endometritis-hypoluteolysis and ketosis-hypoluteolysis was diagnosed in 10%, ketosis-endometritis in 19%. Multiorgan pathology ketosis-endometritis-hypoluteolysis was registered in 7% of animals.

The same authors in the winter (January-February) in 33.8% of new cows revealed obstetric pathologies, including patients with ketosis 6.0%, endometritis – 15.0%, hypoluteolysis – 9.0%, a combination ketosis-endometritis – 1.5% and endometritis-hypoluteolysis – 2.3%. In the spring (March-May obstetric pathologies revealed 36.4% of cows, of which 7.4% were sick with ketosis, endometritis – 17.3%, hypoluteolysis – 8.2%, combination ketosis-endometritis – 1.3% and ketosis-endometritis-hypoluteolysis – 2.2%. In the summer (June-July) obstetric pathologies revealed 24.5% of cows, among which 1.9% had ketosis, endometritis – 15.6%, hypoluteolysis – 5,8%, the combination of ketosis-endometritis – 0.6% and ketosis-endometritis-hypoluteolysis – 0.6% (Zubkov and Skliarov, 2018). Topurija and Eskazina (2012) recorded postpartum endometritis in 54.1% of the total number of cows studied, uterine subinvolution – in 8.9%, ovarian hypofunction – in 4.2%, persistent corpus luteum – in 10.6%, follicular cysts – in 11.5%, mastitis – in 19.6%. Most often, the combined pathology manifested itself in the form of mastitis with endometritis (Rajamannan, 1993; Bacha and Regassa, 2010; Borş *et al*., 2016; Rodin, 2016; Zduńczyk and Janowski, 2020).

In the works of Maunsell *et al*. (2012) and Bollwein (2015) discussed the possibility of developing metritis in cows in the postpartum period against the background of hypocalcemia, Markusfeld (1985) – metritis and ketosis, Dervishi *et al*. (2020) – metritis, hypocalcemia and ketosis, and a number of other authors report the risk of delayed litter, metritis, mastitis, ketosis, postpartum hypocalcemia, abomasum displacement and their combination (Curtis *et al*., 1985; Goff and Horst, 1997; Hossein-Zadeh and Ardalan, 2011; Chamberlin *et al*., 2013; Márquez *et al*., 2016; Rodríguez *et al*., 2017; Torres *et al*., 2020). At the same time due to hypocalcemia increases the risk of ketosis by 8.9 times, mastitis – by 8.1 times, rennet displacement- by 3.4 times, metritis and retention of manure – by 3.2 times (Lebedev *et al*., 2018).

CONCLUSION

Puerperium is one of the most important moments in the life of a female, playing a crucial role in restoring the reproductive function and milk productivity of cows. During this period there

is a basis for structural and functional disorders in individual organs and systems, ie the prerequisites for the development of pathological processes.

Diseases in the postpartum period of cows have species and age polymorbidity, characteristic of highly productive animals and first-borns and are especially common in hypovitaminosis and trace elements. Puerperal pathologies are quite common and covered in the literature on individual diseases, but limited – by their combination (co-, poly- and multimorbidity, multiorgan failure, multiple, complex, combined and concomitant pathology, associated and multifactorial diseases or polypathy).

There is no doubt about the negative impact of these pathologies on the state of reproduction of the herd, impaired fertility, calf yield and milk productivity.

Their occurrence is associated with unsatisfactory conditions for keeping and feeding cows (with insufficient or limited exercise, poor diet), mainly in the autumn-winter and winter-spring periods of the year, especially in the stable keeping of animals. The pathogenesis is based on metabolic disorders and endocrine dysfunctions with a decrease in the body's resistance, which is complicated by the action of adverse environmental factors.

Options for combining postpartum pathologies are diverse with the involvement of metro- and ovariopathies, udder diseases, fallopian tubes and metabolism in the form of inflammatory processes and dysfunctions. In particular, of the diorgan pathologies are hypogonadism-metritis, hypocalcemia-metritis, hypoluteolysis-metritis, retained placenta-metritis, ketosis-hypoluteolysis, ketosis-metritis, mastitis-metritis and subinvolution of the uterus-metritis, and polyorgan – uterus-cervicitis, vaginitis-metritis-cervicitis, hypocalcemia-ketosis-metritis, hypoluteolysis-ketosis-metritis, hypoluteolysis-metritis-salpingitis-salpingo-oophoritis, retained placenta-mastitis-metritis, ketosis-metritis.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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