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| **RESEARCH ARTICLE**

**Review Article: Normal Clinical and Hematological Indices in Newborn Lambs**

**Baidaa H.R. Al-Mahna<sup>1</sup> ✉ Hala S.R. AL-Tae<sup>2</sup>, Hasanain A.J. Gharban<sup>3</sup> and Zahraa R. Abbas<sup>4</sup>**

<sup>1</sup>*Department of Anatomy and Histology, College of Veterinary Medicine, University of Wasit, Wasit, Iraq*

<sup>2</sup>*Department of Microbiology, College of Veterinary Medicine, University of Wasit, Wasit, Iraq*

<sup>3</sup>*Department of Internal and Preventive Veterinary Medicine, College of Veterinary Medicine, University of Wasit, Wasit, Iraq*

<sup>4</sup>*Basic Sciences Branch, College of Dentistry, University of Wasit, Wasit, Iraq*

**Corresponding Author:** Hasanain A.J. Gharban, **E-mail:** [hghirban@uowasit.edu.iq](mailto:hghirban@uowasit.edu.iq)

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| **ABSTRACT**

Knowledge about the hematological characteristics of baby sheep holds essential value for both physiological understanding and health issue detection. The neonatal lambs show a high affinity between their hemoglobin and oxygen molecules to support oxygen transport functions at the beginning of their extra-uterine life during the first months. The body accomplishes this adaptation to maximize the use of restricted cardiac reserve during the newborn stages. Newborn lambs have to face challenges in a new environment totally different from that of the uterus. Adaptation to extra-uterine life involves functional changes, with almost every organ and system in the body undergoing a series of metabolic and anatomical modifications. About 10% of the live-born lambs may die during the first days due to different factors, and the percentage of mortality could increase till weaning. The modification and adjustment of the extra-uterine environment according to the needs of newborns in the first week of life can greatly reduce the death rate. However, because of differences in breed, the adaptation response to the new environment by lambs may differ, and evidence does exist that lambs may fail to cope with the modifications associated with independent life because of their inability to maintain homoeothermic and establish breathing. The clinical examination of an individual lamb includes a physical examination after taking the case history problem and recording the environmental changes. The purpose of clinical examination is to arrive at a diagnosis, strategy for treatment, and prevention of the problem. The hematological parameters are helpful to determine the health and nutritional status of animals. Documentation of these valuable indices in the neonatal period is helpful in establishing suitable physiological baseline values for various breeds of sheep.

| **KEYWORDS**

Hematology, Sheep, Management factors, Environmental factors, Iraq

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**1. Introduction**

Sheep are referred to as small ruminants reared for diverse reasons and under diverse conditions, and they are managed for commercial reasons. The profitability of small ruminant enterprises for meat production depends on the number of young animals that are either sold for meat or join the flock as replacement breeding stock; the number raised for the market is a reflection of complete flock/herd management throughout the year (Morris, 2017; Gadekar et al., 2023). The care for lambs begins when the fetus is in the uterus of the dam, especially in the last one-third of gestation. Lambs are thus presented as care before and after birth. During the first stages of milk

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feeding, the abomasum (true stomach) and small intestine play a relatively important role with respect to digestion and nutrition (Wang et al., 2020). In young lambs, as well as other young ruminants, the suckling reflex triggers the esophageal groove to close so that milk (Kaba et al., 2018). Mortality in sheep, especially in neonatal life, causes considerable economic losses to the sheep industry (Dwyer et al., 2016). A lamb that has an empty-looking abdomen and is tucked up may be starving. A depressed neonatal lamb that is weak and unable to stand may be hypothermic and/or hypoglycemic (Bienboire-Frosini et al., 2023). Reluctance to walk or a stiff gait may indicate joint illness (Costa et al., 2020). Neonatal lamb mortality is one of the major factors in the impairment of productivity in sheep-raising enterprises around the world (Abbott, 2024). Mortality can obviously vary with the management system, from intensive to extensive lambing and highly supervised to minimal (Erichsen et al., 2024).

## **2. Clinical indices**

The clinical examination of sheep includes taking of case history, physical examination, and environmental changes (Stockler et al., 2020). The purpose of clinical examination is to arrive at a diagnosis and develop a strategy for treating and preventing disease. A complete examination of sheep requires:

- 1- Physical examination
- 2- Examination of management and environment.

Sheep may have rapid respiratory rates, especially in high ambient temperatures or during exercise. Also, the respiratory rate increases in young animals and then decreases gradually (Habibu et al., 2019). Physical examination of the newborn should include those body systems at particular risk for congenital defects. The examination of a sick lamb should particularly include palpation of the umbilicus for evidence of navel illness and thorough examination of the joint for joint illness and polyarthritis. Hypothermia is a common condition that can be fatal without treatment since the normal temperature in a lamb is 39-40°C (Sargison et al., 2018; Rajamohan et al., 2015). Severely hypothermic lambs can have temperatures below 32°C, and those with temperatures below 37°C require intensive treatment (Gök and Gul, 2018). The heart rate of a normal lamb is 80-100 beats per minute, and the respiratory rate is 36-48 breaths per minute. Joint illness is a relatively common condition in lambs, and previous observations may increase the suspicion of this condition (Kviesulaitis et al., 2018).

### **2.1 Birth body weight**

Birth weight has an important relationship with the mortality rate of newborn lambs until weaning, as an increase in birth weight leads to a reduced mortality rate of newborn lambs. In the uterus, males appear to grow faster than females, and no effect of mixed-sex twin pairings on the average birth weight of each sex has been reported (Roca Fraga et al., 2018; Sveinbjörnsson et al., 2021). Several studies have revealed that the mortality rate in male lambs is higher than in female lambs (Festa-Bianchet et al., 2019; Abecia et al., 2020; Tesema et al., 2020). The lack of genetic variation has led to recommendations that the improvement of lamb survival should rather be based on modification of the environment to create conditions suitable for the survival of lambs (Miller et al., 2018; Abebe et al., 2023). Low birth weight lambs, being less energetic and having low tissue reserves, take much more time to reach the udder for suckling than heavier lambs (Van Eetvelt, 2020). Lambs' birth weights were significantly influenced by lambing season and type of birth but not by the age of the dam (Kramarenko et al., 2021). In addition, body weight and growth rate can also be influenced by an elevated ambient temperature due to its effect on the metabolism, decreased anabolic, and increased catabolism (Van Wettere et al., 2021). Birth weight may be another factor that has a direct or indirect effect on growth rate as vigorous lambs (5.2 kg) compared to weak lambs (4.1 kg) have better suckling potential (Agricoltura, 2019; Burger, 2019).

### **2.2 Physical examination**

#### **2.2.1 Body temperature**

In the uterus, the fetus is completely adapted to its environment, having a stable temperature about 0.5°C higher than the maternal temperature (Al-Gharban, 2017; Korkh et al., 2024). The neonatal lambs are not capable of facing cold and heat stress, and they show a response to high temperature by changes in respiratory rate and irregular breathing (Sejian et al., 2022; Tüfekci and Sejian, 2023). Birth weight is also an important factor that plays an important role in the maintenance of body temperature and growth in new life (Nel et al., 2021). Lambs born

lightweight (4.1 kg) are known to have a reduced ability to maintain body temperature as compared to heavier (5.2 kg) lambs (Ajaj et al., 2021; Steyn, 2022). An increase in ambient temperature could result in the rise of rectal, skin, and scrotal temperatures, which could vary depending on the day's timing and seasons (Kahwage et al., 2018).

An increase in live weight during the neonatal period is a well-established phenomenon that can be influenced by nutrition, high temperature, and diseases (Perry et al., 2019; Farooq et al., 2024). Recently, a number of studies reported an increase in rectal and skin temperatures with an increase in ambient temperature (Abecia et al., 2020; De et al., 2023). Various factors are responsible for the irregular pattern of scrotal skin temperature, including humidity and fluctuation in temperature during cloudy days. Sheep have efficient thermal homeostasis mostly in the first month of the postpartum period (Coffie, 2020). Homeostasis is achieved by evaporation of water by the respiratory tract or sweating. Generally, sheep as homeotherms maintain their body heat balance by dissipation of the excess heat from their bodies when exposed to elevated temperatures (Pérez et al., 2020). Rectal temperature increases only when the physiological mechanisms of the body are non-productive to counteract the unnecessary heat load (Sargison et al., 2018). The thermoregulatory process is also influenced by birth weight, and some reports suggest that lighter lambs have a reduced capability to sustain body temperature at birth (dos Santos et al., 2023).

### 2.2.2 Heart rate

Fetal heart rates are variable from low to high around parturition and then develop typical variability depending on activity in later life as the mean heart rate significantly increased from the day of birth to 8 days (Mrocki et al., 2018; Cruz-Aleixo et al., 2021). In one study, authors reported a gradual decrease in the heart rate of lambs during the first 30 days of their life, whereas it is well-documented that heartbeat varies following walking, exercising, and suckling processes (Kasai et al., 2019; McGillick et al., 2019). Similarly, pulse rate is also affected by morning and noon timings due to various ambient temperature peaks. The pulse rate may decrease due to a decrease in the metabolic rate (Falck, 2019; Steyn, 2022).

### 2.2.3 Respiratory rate

Initiation of regular breathing seemed to affect the respiration rate under heat, stress, environmental, and management conditions; regular feeding can affect the respiration rate (Korkh et al., 2024). When the temperature was raised enough to suppress respiratory evaporation, the respiration rate decreased markedly and tended to stabilize and appear much deeper than during normal shallow respiration (Tadesse et al., 2019; McManus et al., 2020). The mean ventilation rate significantly decreased from the day of birth to 8 days during this same developmental period (Veneroni et al., 2020).

## 2.3 Umbilicus examination

At birth, the umbilical cord, which provides vascular flow between the fetus and placenta, is clamped and cut. Within the first week of life, the remnant umbilical cord stump separates from the neonate, creating the umbilicus (Blank et al., 2018; Fordyce et al., 2018). The breaking of the umbilical cord too soon will prevent oxygen from passing to the lamb; if this occurs, respiration must be established as soon as possible after expulsion (Hooper et al., 2015). Umbilical infections are encountered frequently in practice and usually result in liver abscessation, but they may also lead to septic peritonitis, localized fibrinous peritonitis, or polyarthritis. These conditions are usually accompanied by anorexia and mortality (Moeller, 2012; AM Farghali et al., 2020; Newcomer et al., 2020).

Large numbers of lambs die in the first days of life from bacterial infections such as navel illness (Holmøy et al., 2017). Problems occurring later on, e.g., joint illness, liver and lung abscessation, meningitis, and spinal abscesses, also originated during this time; bacteria infect lambs mainly through the navel, umbilical infections may result in reduced growth rate in lambs (Penrith and Shrewsbury, 2010; Congenita, 2011). A wet navel provides a direct route for bacteria to travel into the lamb. The navel should be treated as soon as possible after birth and ideally again 6 hours later. Tincture of Iodine is the best product to use as it will dry the navel and has an antiseptic effect. It is important to dip the entire navel in an iodine solution (Hanson and Robinson, 2019; Jackson, 2024). The dried-up umbilical cord usually was reported to separate (or slough) by the fourth to sixth postnatal day; an umbilical cord that remained attached beyond 2 weeks after birth was considered delayed; attachment beyond 3 weeks was outside the range of normal, anatomic anomalies also are associated with delayed cord separation (Malhotra et al., 2020).

### **2.3.1 Joint Examination**

The joint should be palpated for swelling and soreness, and the septic joints in small ruminants are typically very painful yet variably distended (McQuillan, 2023). Joint illness is usually the result of a bacterial infection from a contaminated environment entering via the navel, and it affects joints in the early stages until the joint swelling becomes obvious (Hunter, 2020; Jackson, 2024). A range of factors can cause an ill-thrift in lambs through various mechanisms. These factors include malnutrition, trace element and vitamin deficiencies, parasitic infections, orf, lameness, and chronic suppurative infections. In Lambs, it usually originates from the digestive system or from respiratory, cutaneous, or umbilical infections (Baird and Shipley, 2020; Abbott, 2024; Esraa et al., 2025).

## **3. Hematological indices**

The hematological parameters are helpful in determining the health status of animals. Documentation of hematological indices in the neonatal period is helpful in establishing suitable physiological baseline values for various breeds of sheep that, in turn, could be employed in the pragmatic evaluation of the administration practice, nourishment, and diagnosis of health condition in the most critical period of life (Gharban and Yousif, 2020; Al-Eodawee et al., 2024; Almaliky et al., 2024).

### **3.1 Red blood corpuscles (RBCs)**

The common method to evaluate the functional state of erythrocyte activity depends on their total count in a certain volume unit of blood and on estimating packed cell volume as well as determining hemoglobin concentration (Briggs, 2009; Buttarello, 2016). From these three measurements, it can estimate erythrocyte size and carried hemoglobin amount, which will determine erythrocyte physiologic efficiency (Etim et al., 2014). A researcher stated that the most important factor affecting hematologic values is age, which had an effect on erythrocyte count when it was found that erythrocyte count was higher among young sheep compared to older sheep. Also, the erythrocyte count was higher among males than females (de Souza et al., 2018). Ruminant fetuses and neonates have greater amounts of RBC than adults (Herdt and Hoff, 2011; Wood, 2022).

The mean values of red blood cell counts decreased significantly in the first month postpartum in both males and females (Saddiqi et al., 2011). The higher red blood cell counts in lamb given birth to lambs of 2-3Kg with a decreasing trend as the weight of the lamb increased probably reflects that higher birth weight of neonate has a suppressing effect on the hematology of the dam (Kubkomawa, 2019). Variation could be due to differences in environmental, management, or genetic factors; values of corpuscular elements can vary in different physiological statuses, age groups, and breeds (Decampos et al., 2013; Khalil et al., 2022).

### **3.2 Hemoglobin (Hb)**

A number of studies recorded that normal hemoglobin concentration among sheep ranged between 9-15 gm /deciliter (Etim, 2015; Barsila et al., 2020). One previous study confirmed that hemoglobin concentration increased with age in both sexes (Egbe-Nwiyi et al., 2000). Other studies recorded a high level of hemoglobin in both sexes, which was 14.5gm / deciliters in females and 15.9 gm/deciliter in males (Eschbach et al., 1980). Rams have a higher level of hemoglobin concentration than ewes (Jelinek et al., 2014). In contrast, other studies state that sex didn't affect the concentration of hemoglobin in ewes (Carlos et al., 2015). In one study, authors recorded that age has a significant effect on the hemoglobin concentration of lambs (Asadi et al., 2022), while others recorded that hemoglobin concentration increases with the age of sheep (Carlos et al., 2015). Other studies reported that the age of sheep didn't affect hemoglobin concentration, and the values of hemoglobin were adjusted according to the oxygen-carrying capacity of the blood (Zhong et al., 2011; Etim et al., 2014).

### **3.3 Packed cell volume (PCV)**

Several researchers stated that packed cell volume was not stable among the age group from birth to 12 months, as it increased gradually with age, and it returned to be unstable among the old age sheep (Vanimisetti et al., 2004; de Souza et al., 2018). The percentage of packed cell volume is also affected by age, breed, season, and nutrition (Igbokwe et al., 2016). It has been reported differences in packed cell volume between males and females since males have a higher packed cell volume than females due to hormonal effects which could be abolished by castration and spaying (Egbe-Nwiyi et al., 2000; Boyi et al., 2020).

### **3.4 Platelets (Thrombocytes)**

The normal thrombocyte count in sheep was (100,000/ $\mu$ l - 250,000/ $\mu$ l), and in most animals, less than 100,000/ $\mu$ l is considered clinically significant, although prolonged bleeding rarely is observed until the total count is below 50,000/ $\mu$ l in all probability (Carneiro et al., 2013; Biolato et al., 2023). The main function of thrombocytes is to repair damaged endothelium, which is injured to the endothelium exposed under lying collagen (Neubauer and Zieger, 2022). Severe hemorrhage may reduce the platelet number; it must be recognized that the number of platelets may be normal, but coagulation problems may occur when the platelet function is abnormal (Estcourt et al., 2016). Hemorrhage that results from thrombocytopenia takes the form of petechiation of mucous membranes and skin. Thrombocytopenia occurs in disease conditions affecting bone marrow (Smock and Perkins, 2014; Marsch, 2022).

### **3.5 White blood cells (WBCs)**

Different authors have stated that animal's age had a great effect on the total white blood cell count in sheep when he mentioned that the total count of white blood cells was  $9.37 \times 10^3$  /ml during the first two weeks of life, and then increased gradually to reach  $16.000 \times 10^3$  / ml (Greguła-Kania et al., 2021). The count of white blood cells was decreased at four months of age, and lymphocytes count was also increased gradually from birth to reach three months of age (Edjtehadi, 1978; Greguła-Kania et al., 2021). However, neutrophil count remained unchanged during the first three months of life, but they increased the animal's maturation (Ramos et al., 2019).

#### **3.5.1 Neutrophils**

The neutrophils' phagocytic function is important in infectious conditions and in inflammation (Worku et al., 2021). Neutrophilia refers to an increased number of neutrophils in circulation that occurs in response to infection and neoplasia, while neutropenia refers to a decreased number of neutrophils in circulation that occurs in viral infection and increased destruction of neutrophils in circulation (Burn et al., 2021). Production of neutrophils is independent of the body's demand and the health of animals; breed, temperature, and environmental factors also influence their production. Animal sex is also believed to have an effect on neutrophil count (Alhussien and Dang, 2019; Blanter et al., 2021; Khachatryan et al., 2022).

#### **3.5.2 Lymphocytes**

The lymphocytes' phagocytic function is important in inflammation. It increases with increased age; when the lamb reaches three months of age, it represents 70-80% of the total white blood cell population, then begins to decline in numbers (Cronkite and Strutt, 2018; de Souza et al., 2018).

#### **3.5.3 Monocytes**

The monocytes are the largest of the circulating cells; they are rather granular, which is the main function of monocytes. Monocytopenia refers to an increased number of monocytes in circulation that occurs as a part of the acute steroid response (Ehrchen et al., 2019; Hume et al., 2019; Lackner et al., 2023).

#### **3.5.4 Eosinophils**

The eosinophils have a detoxified function; they also inhibit edema production. Eosinophilia refers to an increased number of eosinophils in circulation that occurs in tissue injury in hypersensitivity reactions (Fung et al., 2022; Xie et al., 2025).

#### **3.5.5 Basophiles**

The function of basophiles is to release histamine and initiate the inflammatory response. Basophilia refers to an increased number of basophiles in circulation, which may be an indication of a maturation defect associated with toxemia (Shulpekova et al., 2021; Zhang et al., 2021).

## **4. Conclusion**

Mammalian fetal wound healing in the late stages includes scar formation from mast cells that play essential roles in the inflammatory response. Here, further research investigating wound healing across intervals of fetal, newborn, and adult lamb development is very important since it indicates that fetal wounds heal faster by means of increased mesenchymal cell multiplication and collagen building activities, which operate at elevated rates in fetal subjects than in newborn and adult animals.

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