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Technical note

# Acid–base balance modifications in the lamb and goat kids during the first week of life

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**Abstract**

In the lamb and the goat kid, the neonatal period represents a critical stage, as the newly born animals have to adapt to the extra-uterine life. The purpose of this study was to obtain physiological reference values as indicators of dynamic homeostatic processes occurring during the first week of life in the lamb and kid.

Two groups of five "Valle del Belice" lambs and five "Girgentana" kids, respectively, were used in the trial. Starting from the first day of birth and for the following 6 days, all animals underwent blood sampling by means of a jugular venipuncture and blood pH, carbon dioxide partial pressure ($pCO_2$), oxygen partial pressure ($pO_2$), standard bicarbonate concentration (SBC), bicarbonate concentration ($HCO_3^-$) and total carbon dioxide ($TCO_2$) were determined using a selective ion haemogasanalyzer. The values were statistically processed for repeated measurements and the Bonferroni test of multiple comparisons, to determine significance differences parameters. There were no statistically significant differences regarding the pH, $pCO_2$, $HCO_3^-$, and $TCO_2$ between the two groups, Group A (GA: lambs group) and Group B (GB: kids group). Significant differences were recorded for the pO2 values (GA: $P < 0.001$; GB: $P < 0.0001$) and SBC (GA: $P < 0.01$; GB: $P < 0.01$). $pO_2$ values showed a constant and significant increase ($P < 0.05$) both for GA and GB groups, during the earliest part of the investigation. Furthermore $pO_2$ values in the GB group showed a significant increase ($P < 0.05$), starting from the second day of the study. SBC showed a gradual increase during the observation period. Significant differences ($P < 0.05$) were recorded in the GA group between the second and third day, compared to the seventh day and in GB group for the first day, compared to the fourth and the fifth day. These results outline the occurrence of acid–base homeostatic mechanisms, and the physiologic evolution of the organs and parameters under investigation. Furthermore results underline differences between the species that needs to be further researched.


*Keywords:* Acid–base balance; Lamb; Kid; Neonatal physiology

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## 1. Introduction

For the lamb and the goat kid, the first week after the birth (neonatal period) represents a critical time during which all organ functions must adapt to the extra-uterine life. Lamb and kid mortality rates are generally higher than other farm species and reaches a peak during the perinatal period (Eales et al., 1983; Puevis et al., 1985). Birth and the subsequent 24 h represents a critical stage for the detection of, e.g. lamb and kid health problems. This period represents a transition phase between the fetal functions and those of the newborn, in which all homeostasis (cardiovascular, respiratory, metabolic and thermoregulatory) is fully established. Lamb and kid mortality rates are higher between the first 2–48 h of life and reflects mostly on respiratory and thermoregulatory disorders (Walser and Bostedt, 1993). Therefore extra care must be taken to support animal homeostasis during this period and has to be specific as to avoid any iatrogenic side-effects. Among the techniques useful to make a diagnosis of pulmonary and metabolic dysfunctions, haemogasanalytical examinations could be critical as it allows metabolic and qualitative assessment of gas exchanges by means of $O_2$ and $CO_2$ analyses (Askin, 1997).

Studies on acid–base balance and blood gas pressures showed a modification of the moderate metabolic and respiratory acidosis present at birth and during the first 2 days of life (Andrén, 1982). The greater part of investigations regarding the postnatal development of respiratory function and of acid–base balance have been focussed on lambs during experimental hypoxia or normoxic and/or hypoxic hypercapnia (Bureau et al., 1990; Rurak et al., 1990; Arbeille et al., 1995; Canet et al., 1996; Calder et al., 1997).

Given the importance of having physiological reference values as indicators of dynamic homeostatic processes taking place during the first 24 h following birth and in the first week of life the goal was the assessment of several haemogasanalytical parameters, regarding the respiratory function and the acid–base balance regulation, during the first week of life in the lamb and goat kid.

## 2. Material and methods

For this study, five "Valle del Belice" lambs with a mean body weight at birth of $4.0 \pm 0.1$ kg (GA), and five "Girgentana" kids with a body weight at birth of $3.5 \pm 0.1$ kg (GB), clinically healthy and full term born, were used. The study was carried out in spring in Sicily and animals were maintained on mother's milk and were kept in a sheltered pen. From all animals, starting from the day of birth and for the next 6 days (08:00) 3 ml blood was sampled by means of a jugular venipuncture, using pre-heparinized syringes for haemogasanalysis (frozen-dry lithium-heparin), with a 23 G needle. Samples were analyzed within 15 min following collection using 40 μL of blood.

Blood pH, carbon dioxide partial pressure ($pCO_2$), oxygen partial pressure ($pO_2$), standard bicarbonate concentration (SBC), bicarbonate concentration ($HCO_3^-$) and total carbon dioxide ($TCO_2$) were determined using a selective ion haemogasanalyzer (Stat Profile pHOx, Nova Biomedical). Furthermore, due to the temperature influences on blood gas partial pressure (Nunn et al., 1965), for each assessment the analyzer reference temperature was individually set on the basis of the animal's rectal temperature recorded by means of a digital thermometer.

An ANOVA statistical analysis for repeated measurements and a Bonferroni test of multiple comparisons was used to determine the statistical differences between mean values of the studied parameters from the first to the seventh day of the observation period.

## 3. Results

In Table 1 the mean values of the haemogasanalytical parameters measured are set out with the respective standard deviations for lambs and kids and Fig. 1 illustrates the $pO_2$ and SBC mean values.

No significant differences for pH, $pCO_2$, $HCO_3$, and $TCO_2$ were recorded between the two groups (GA and GB), while significant differences were found between the $pO_2$ values (GA: $P < 0.001$; GB: $P < 0.0001$) and SBC (GA: $P < 0.01$; GB: $P < 0.01$)(Fig. 1). When applying the Bonferroni test, $pO_2$ values showed a constant and significant increase ($P < 0.05$) both in the GA and GB groups, during the earlier part of the investigation. Furthermore $pO_2$ values in the GB group showed a significant increase ($P < 0.05$), starting from the 2nd day of the study.