Effects of xylazine on acid-base balance and arterial blood-gas tensions in goats under different environmental temperature and humidity conditions

E G M Mogoa\textsuperscript{a}, G F Stegmann\textsuperscript{a} and A J Guthrie\textsuperscript{b}

\textbf{ABSTRACT}

The effects of acute exposure to 3 different temperature and humidity conditions on arterial blood-gas and acid-base balance in goats were investigated after intravenous bolus administration of xylazine at a dose of 0.1 mg/kg. Significant (P < 0.05) changes in the variables occurred under all 3 environmental conditions. Changes in pH, partial pressure of oxygen and oxyhaemoglobin saturation were observed, and the minimum values for oxygen tension and oxyhaemoglobin saturation were observed within 5 min of xylazine administration. The pH decreased to its minimum values between 5 and 15 min. Thereafter, the variables started to return towards baseline, but did not reach baseline values at the end of the 60 min observation period. Increases in the partial pressure of carbon dioxide, total carbon dioxide content, bicarbonate ion concentration, and the actual base excess were observed. The maximum increase in the carbon dioxide tension occurred within 5 min of xylazine administration. The increase in the actual base excess only became significant after 30 min in all 3 environments, and maximal increases were observed at 60 min. There were no significant differences between the variables in the 3 different environments. It was concluded that intravenous xylazine administration in goats resulted in significant changes in arterial blood-gas and acid-base balance that were associated with hypoxaemia and respiratory acidosis, followed by metabolic alkalosis that continued for the duration of the observation period.

Acute exposure to different environmental temperature and humidity conditions after xylazine administration did not influence the changes in arterial blood-gas and acid-base balance.

\textbf{Key words}: acid-base, anaesthesia, blood-gas, goats, xylazine.


\textbf{INTRODUCTION}

Xylazine is widely used in various animal species for its potent sedative, analgesic and myorelaxant properties\textsuperscript{1}. Reported adverse effects of xylazine are hypoxaemia, carbon dioxide retention and acid-base disturbances\textsuperscript{2,4–7,10,11,16,17,21}. The field use of xylazine often requires the administration of this agent to compromised animals exposed to acute changes in environmental conditions. Xylazine administered to heat-stressed heifers resulted in a prolonged action of xylazine\textsuperscript{5}. It was speculated that the duration of the effect of xylazine might be altered during acute changes in environmental conditions, and therefore result in increased morbidity or mortality.

The purpose of this study was therefore to evaluate the short term effects of xylazine in goats under different environmental temperature and humidity conditions.

\textbf{MATERIALS AND METHODS}

Six adult, clinically healthy, non-descript indigenous African breed, castrated male goats, weighing between 21.0 and 34.0 kg (mean 28.2 ± 1.0 SEM), were used in this study. They were housed indoors in individual crates in premises devoid of logical monitor (Propaq\textsuperscript{®}, Critikon) for drug administration. The relocated carotid artery on the right side was catheterised with a 20G catheter (Medican\textsuperscript{®}, Medical Specialities) for arterial blood collection. Both catheters were flushed with heparinised saline, capped and sutured to the skin with No. 2/0 nylon (Ethicon). The animals were then transferred to the temperature- and humidity-controlled room, and maintained in lateral recumbency. An oesophageal thermometer probe from a multi-parameter physiological monitor (Propaq\textsuperscript{®}, Protocol Systems, Oregon) was nasally introduced with the tip in the distal third of the oesophagus. After a stabilisation period of 10 min, xylazine hydrochloride (Rompun\textsuperscript{®}, Bayer Animal Health, Isando) was injected intravenously as a bolus at a dose of 0.1 mg/kg body mass. Arterial blood samples (2 ml) were anaerobically collected from the carotid artery into 2.5 ml heparinised syringes and stored in iced water for analysis within 2 h of collection with a blood-gas analyser (Radiometer ABL 300, Copenhagen, Denmark). The samples were corrected for
and carbon dioxide (PaCO₂), oxyhaemoglobin saturation (SAT), bicarbonate ion ([HCO₃⁻]), and change in body temperature. The samples were collected at ‘time zero’ (baseline) and 5, 15, 30, 45, and 60 min post-xylazine injection. The blood was analysed for pH, arterial partial pressures of oxygen (PaO₂), and carbon dioxide (PaCO₂), oxyhaemoglobin saturation (SAT), bicarbonate ion ([HCO₃⁻]), actual base excess (ABE) and total carbon dioxide content (TCO₂).

**RESULTS**

The results of the mean (±SEM) arterial blood-gas tensions and acid-base balance variables in xylazine-treated goats. The acute effects of xylazine on cardiopulmonary function and changes in body temperature have been reported in full.⁴ The effects on cardiopulmonary function and changes in body temperature have been reported in full.⁴ Body temperature increased in the 34 °C environment with a maximum of 0.5 °C, and decreased in the 14 and 24 °C environments with a maximum decrease of 1.5 °C in the 14 °C environment.⁴ Xylazine caused statistically significant (P < 0.05) changes in pH, PaO₂, PaCO₂, TCO₂, [HCO₃⁻], and SBE within 5 min of administration, except for the [HCO₃⁻] in the 14 °C environment, TCO₂ at the 24 °C environment and the SBE in all 3 environments. The maximum decrease in PaO₂ and SAT occurred within 5 min of xylazine administration. The PaO₂ decreased to 4.0 (0.4) kPa in the 14 °C environment and the SAT to values between 42.8% and 43.5 (6.3)% under the 3 environmental temperatures. The PaO₂ and the calculated acid-base variables, SBE and TCO₂, remained significantly different from baseline (time 0 min).

**DISCUSSION**

Acute changes in environmental temperature and humidity conditions did not effect arterial blood-gas and acid-base variables in xylazine-treated goats. However, significant (P < 0.05) changes in arterial blood-gas tensions and acid-base balance (Table 1) were observed under all 3 sets of environmental conditions. The administration of xylazine was also associated with deep sedation, and changes in cardiopulmonary function⁴ and body temperature⁴. The changes in arterial blood-gas and acid-base balance variables observed in this investigation were in agreement with changes previously reported in cattle⁴,⁶, goats⁴,¹¹ and sheep⁴. The time of maximal change (after 5 min) was somewhat shorter compared to the previously reported times of maximal change around 10–15 min. This was probably the result of intravenous administration and the higher dose (0.1 mg/kg) used for xylazine in this investigation. The acute decreases in the PaCO₂, PaO₂, SAT and cyanosis were probably the result of the effects of xylazine on cardiopulmonary function⁴. Arterial hypoxemia associated with minimum oxygen tensions of 4 kPa under all 3 environmental conditions were in agreement with the reported oxygen tensions in sheep of

---

Table 1: Mean (±SEM) of arterial blood-gas tensions and acid-base balance in goats following intravenous xylazine at a dose of 0.1 mg/kg, under 3 different environmental temperature and humidity conditions.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Environment</th>
<th>pH¹</th>
<th>PaO₂²</th>
<th>PaCO₂²</th>
<th>O₂SAT²</th>
<th>[HCO₃⁻]³</th>
<th>Total CO₂⁴</th>
<th>ABE⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>14 °C</td>
<td>7.39 (0.01)</td>
<td>10.7 (0.6)</td>
<td>4.9 (0.2)</td>
<td>93.2 (1.0)</td>
<td>21.3 (0.7)</td>
<td>22.3 (0.8)</td>
<td>-2.2 (0.7)</td>
</tr>
<tr>
<td>0</td>
<td>24 °C</td>
<td>7.39 (0.01)</td>
<td>10.5 (0.5)</td>
<td>4.9 (0.1)</td>
<td>93.8 (1.0)</td>
<td>21.3 (0.7)</td>
<td>22.3 (0.8)</td>
<td>-2.2 (0.7)</td>
</tr>
<tr>
<td>15</td>
<td>34 °C</td>
<td>7.40 (0.01)</td>
<td>10.0 (0.2)</td>
<td>5.0 (0.1)</td>
<td>92.6 (0.8)</td>
<td>21.0 (0.7)</td>
<td>22.0 (0.8)</td>
<td>-1.4 (0.7)</td>
</tr>
<tr>
<td>15</td>
<td>24 °C</td>
<td>7.35 (0.01)</td>
<td>10.6 (0.6)</td>
<td>5.1 (0.1)</td>
<td>92.6 (0.8)</td>
<td>21.0 (0.7)</td>
<td>22.0 (0.8)</td>
<td>-1.4 (0.7)</td>
</tr>
</tbody>
</table>

¹pH units.
²PaO₂ = arterial partial pressure of oxygen (kPa).
³PaCO₂ = arterial partial pressure of carbon dioxide (kPa).
⁴O₂SAT = oxyhaemoglobin saturation (%).
⁵[HCO₃⁻] = bicarbonate ion concentration (mmol/l).
⁶Total CO₂ = total carbon dioxide content (mmol/l).
⁷ABE = actual base excess (mmol/l).

*Significantly different (P < 0.05) from baseline (time 0 min).
4.3 kPa. Hypoxaemia was also reported in other species\textsuperscript{13,14}. The hypoxaemia observed in this investigation was independent of environmental conditions and probably partly the result of hyperventilation due to central respiratory depressant effects of the drug\textsuperscript{15}. Changes in breathing such as bradypnoea, tachypnoea, forced breathing and apnoea as observed in this investigation have been reported previously\textsuperscript{4,9,22}. A decrease in tidal volume has also been reported in goats\textsuperscript{16}. Restrain in lateral recumbency might also have contributed to the changes observed in this investigation. It has been reported in cattle that restraint contributes to similar changes as a result of ventilation-perfusion mismatch, although there is a large difference in body size compared to goats\textsuperscript{1}. Changes in pulmonary function associated with changes in transpulmonary pressure as a result of partial upper respiratory tract obstruction were reported in sheep after xylazine administration. It has been suggested that these changes were the result of $\omega_2$-adrenoreceptor-mediated activity\textsuperscript{17}. Decreases in arterial oxygen tension, haemoglobin saturation, and packed cell volume in compromised animals with anaemia may have an unfavourable effect on peripheral oxygen delivery, especially if associated with decreases in cardiac output and arterial blood pressure\textsuperscript{18}. This may result in increased morbidity or mortality in animals.

Arterial pH decreased below baseline within 5 min of xylazine administration as a result of an increased PaCO\textsubscript{2} (respiratory alkalosis). The PaCO\textsubscript{2} started to improve towards baseline after 30 min, probably as result of recovery from xylazine. However, both PaCO\textsubscript{2} and the total CO\textsubscript{2} remained above baseline. Increases in [HCO\textsubscript{3}]\textsuperscript{-} above baseline occurred over the observation period, and resulted in metabolic alkalosis. The arterial pH was increased above baseline values at 60 min for all 3 sets of environmental conditions despite the PaCO\textsubscript{2} and total CO\textsubscript{2} that were above baseline. The metabolic alkalosis is in agreement with a previous report in goats, although the magnitude of the alkalosis was higher, with a pH of approximately 7.48 and a BE of 5 mmol/L after administration of intravenous medetomidine\textsuperscript{18}. The 60 min observation period used in this investigation may not be optimal for the detection of maximal changes in acid-base variables.

The changes in the acid-base balance and blood-gas tensions observed in this investigation were independent of changes in environmental temperature and humidity conditions. The prolonged action of xylazine in heifers in an environment conducive to heat stress was observed after prolonged exposure to increased ambient temperature. It has been suggested that long-term metabolic changes such as decreased thyroid function and metabolic rate may result in the altered clinical effects of xylazine\textsuperscript{12}. In comparison, the goats in this investigation were exposed to acute changes in the environment, which would not permit metabolic or hormonal changes, and could explain the reason for not observing similar changes in the response to xylazine.

In conclusion, intravenous xylazine in goats exposed to acute changes in environmental temperature and humidity conditions resulted in hypoxaemia, respiratory acidosis, and compensatory metabolic alkalosis. The changes were statistically significant under all 3 sets of environmental conditions, but no significant differences were observed between the different environments.

**ACKNOWLEDGEMENTS**

We would like to thank the Kenya Government, the International Development Association, International Bank for Reconstruction and Development, the World Bank, Bayer – Animal Health Division, South Africa, and the University of Pretoria for their financial and material support.

**REFERENCES**

6. De Moor A, Desmet P 1971 Effect of Rompun\textsuperscript{®} on acid-base equilibrium and arterial O\textsubscript{2} pressure in cattle. Veterinary Medical Review 23: 163–169
13. Mohammed A, Yelwa H A 1993 Effect of xylazine hydrochloride (Rompun\textsuperscript{®}) on Sokoto red goats. Small Ruminant Research 12: 107–113
20. Raptopoulos D, Weaver BM Q 1984 Observations following intravenous xylazine administration in steers. Veterinary Record 114: 567–569