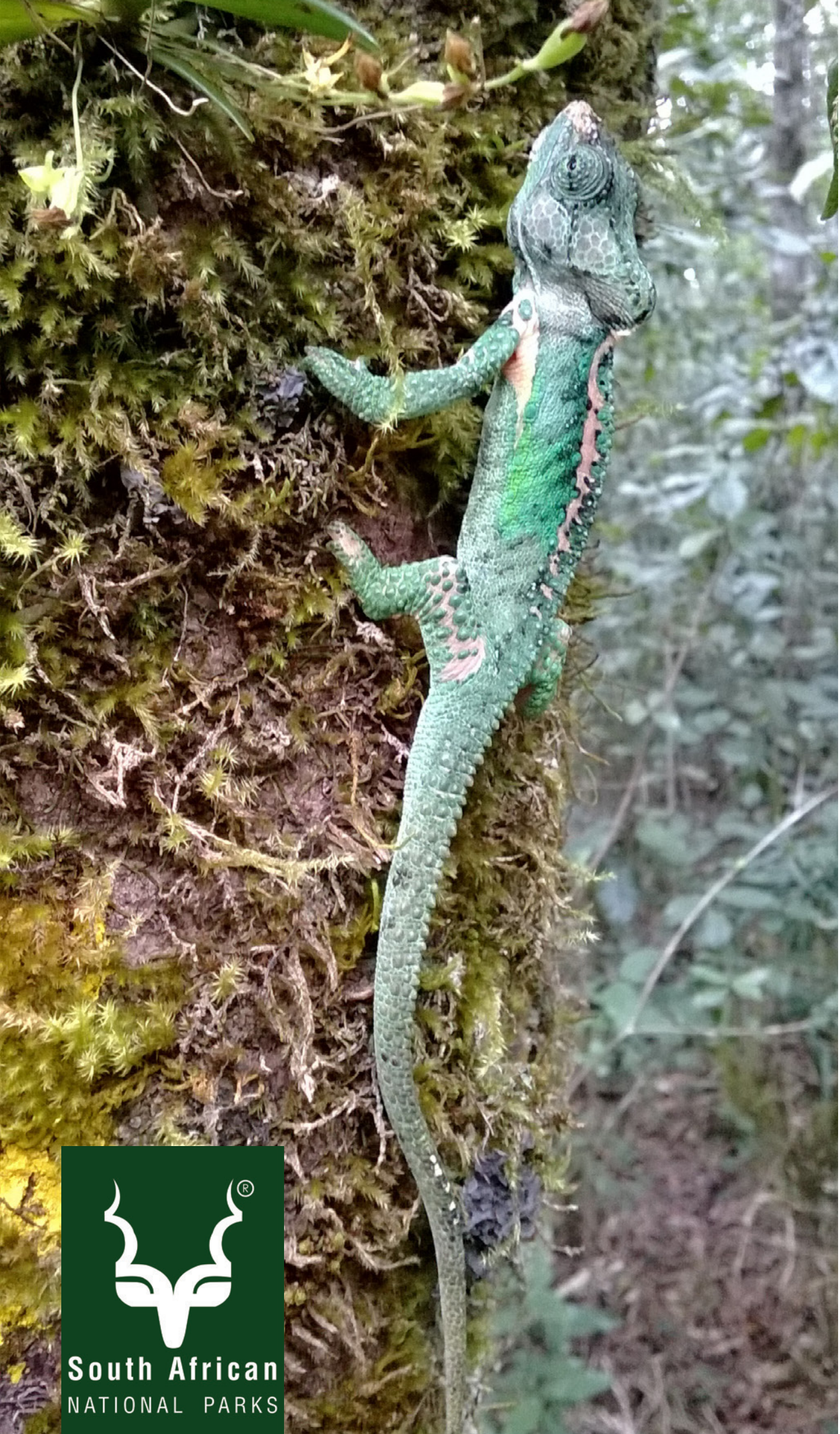

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Content

Improving blood oxygenation monitoring in immobilised white rhinoceros

Text by Thembeka Mtetwa, Edward Snelling & Leith Meyer

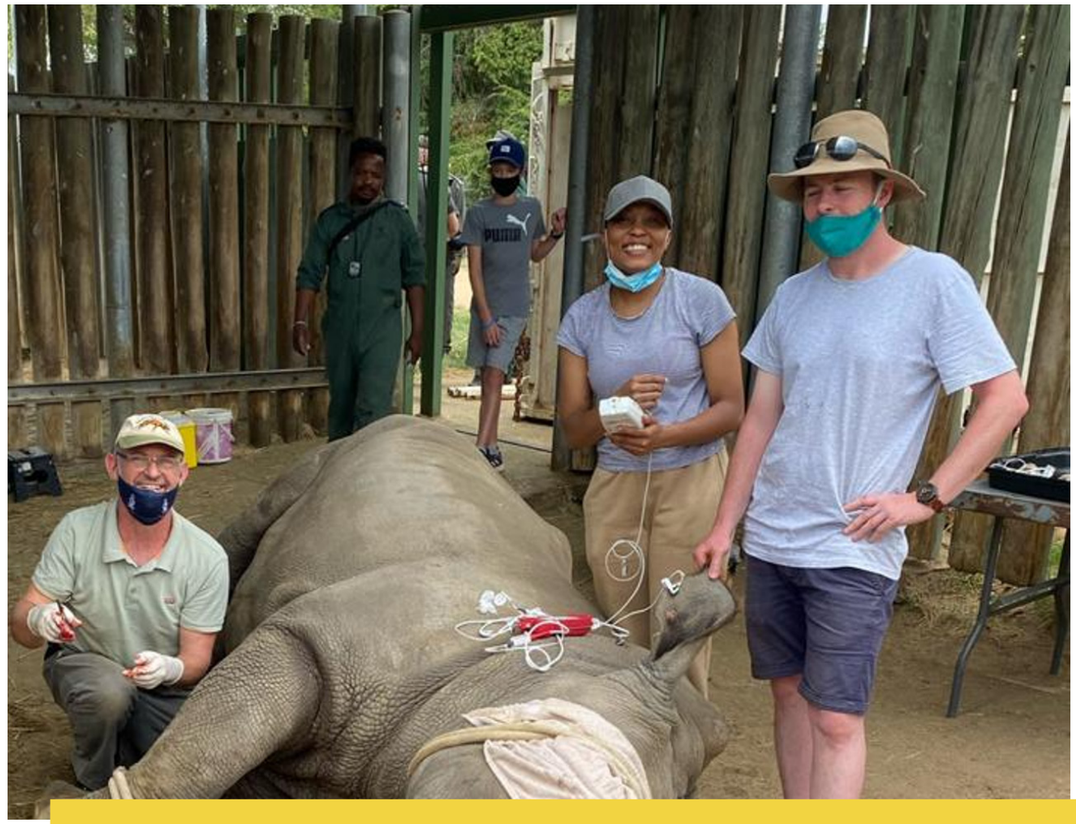
OUR STUDY HAS SHOWN THAT BLOOD OXYGENATION CAN BE MONITORED RELIABLY IN IMMOBILISED SOUTHERN WHITE RHINOCEROS USING A NONIN PALMSAT 2500A PULSE OXIMETER WITH A 2000T TRANSFLECTANCE PROBE, ATTACHED IN THE SPACE BETWEEN THE THIRD EYELID AND THE SCLERA, FACING THE THIRD EYELID, AND WHEN OXYGEN LEVELS ARE ABOVE 70%

The population decline of black and white rhinoceroses remains a crisis around the globe. Rhinoceros management and conservation efforts, such as dehorning, wound treatment and research, require the use of immobilising drugs, such as etorphine and thiafentanyl. However, these drugs affect the respiration of rhino, causing hypoxaemia which results in low blood oxygen levels. Severe hypoxaemia can be acutely life-threatening, and if it is left untreated, can damage the brain and other tissues, leading to tissue hypoxia, organ failure and ultimately death. It is therefore important to find reliable, affordable, and easy-to-use methods to monitor hypoxaemia and blood oxygenation in field settings.

Devices commonly used to monitor hypoxaemia in white rhinoceros (e.g. pulse oximeters and blood analysers) are mostly designed for humans. These devices estimate blood oxygenation, either as partial pressure of oxygen in arterial blood (PaO_2) or arterial oxygen-haemoglobin saturation (SaO_2) and peripheral arterial oxygen-haemoglobin saturation (SpO_2), using blood characteristics of humans. However, the haemoglobin and oxygen-haemoglobin dissociation curve of white rhinoceros' blood is different to that of humans. Determining the magnitude of this potential error and the repeatability of measurements obtained from human devices helps in identifying reliable methods for measuring or calculating blood oxygenation in rhinoceros and will have significant indirect benefits for their conservation.

We examined the reliability of five different methods used to assess blood oxygenation, using the AVOXimeter 4000 benchtop co-oximeter as a reference (gold) standard method. The research was conducted in Kruger where boma-habituated white rhino were immobilised with etorphine-based drug combinations. Non-invasive devices (i.e. Nonin PalmSAT 2500A pulse oximeters and Masimo Radical-7 pulse co-oximeters) with their transflectance and transmission probes were attached at different attachment sites (i.e. third eyelid, cheek, ear, rectum, and/or tail) to monitor the reliability of peripheral arterial oxygen-haemoglobin saturation (SpO_2).

Arterial blood samples were drawn, at different time points, from catheters inserted into the ear pinna and analysed for calculated SaO_2, partial pressure of oxygen and carbon dioxide (i.e., PaO_2 and $PaCO_2$) and pH, using an Enterprise Point-of-Care (EPOC) blood analyser. Blood samples were also analysed for oxygen content (CaO_2) and SaO_2 using the benchtop co-oximeter reference method. Arterial oxygen-haemoglobin saturation was calculated from a Siggaard-Andersen algorithm, modified for rhinoceros, after correcting for EPOC measured PaO_2, $PaCO_2$ and pH.



Immobisation drugs affect the respiration of rhino, causing hypoxaemia which results in low blood oxygen levels and ultimately can be life-threatening. It is therefore important to find reliable, affordable, and easy-to-use methods to monitor hypoxaemia and blood oxygenation in field settings. Thembeka Mtetwa's (middle top) did her PhD on this topic.

We found that only the traditional pulse oximeter was reliable for the measurement of blood oxygenation in immobilised southern white rhinoceros (*Ceratotherium simum simum*). Peripheral oxygen haemoglobin saturation (SpO_2) measurements from the Nonin 2500A PalmSAT pulse oximeter with a 2000T transflectance probe attached to the third eyelid were reliable, but only at 70-100% saturation range. The Nonin 2500A PalmSAT pulse oximeter, at the other attachment sites gave unreliable SpO_2 readings across the entire 0-100% saturation range. The Masimo Radical-7 pulse co-oximeter with a LNCS TF-I AH transflectance probe attached to the third eyelid, and with a LNS YI AH transmission probe attached to the ear pinna gave unreliable readings across the entire 0-100% saturation range. The EPOC's $cSaO_2$ readings were unreliable across the entire 0-100% saturation range. Furthermore, arterial oxygen-haemoglobin saturation calculated by the oxygen content equation using Tucker-derived CaO_2 was also found to be unreliable across the entire 0-100% saturation range. Arterial oxygen-haemoglobin saturation (blood oxygen) calculated by the Siggaard-Andersen algorithm, modified for rhinoceros, was reliable but only at saturations above 90%.

Our study has shown that blood oxygenation and hypoxaemia can be monitored reliably in immobilised southern white rhinoceros using a Nonin PalmSAT 2500A pulse oximeter with a 2000T transflectance probe, attached in the space between the third eyelid and the sclera, facing the third eyelid, and when oxygen levels are between 70% and 100%. Below 70%, it is important to use a benchtop co-oximeter to obtain reliable and accurate measurements in these animals. These findings will assist wildlife veterinarians in monitoring blood oxygenation and hypoxaemia more reliably, continuously, and non-invasively. We hope that this will significantly reduce the number of deaths associated with rhinoceros immobilisation.