Regulation of Pulmonary Circulation in Newborn Llama and Sheep at High Altitudes.
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Adaptation of newborns to high altitudes (HA) requires decreasing the pulmonary vascular resistance within minutes after birth, in a milieu of very low PO₂. Lowland species, such as humans or sheep cannot do it efficiently, resulting in pulmonary hypertension. In contrast, highland species, like the llama, can rapidly reduce pulmonary vascular resistance at altitudes. We examined the role of NO and carbon monoxide (CO) in newborn sheep (NBS) and llamas (NBL) in regulating the pulmonary circulation.

We measured the pulmonary arterial pressure (PAP) and cardiac output of NBS and NBL at 3600m and 580m, basally and with L-NAME. We also determined NOS activity, CO production and eNOS, soluble guanilyl cyclase (sGC) and hemoxygenase-1 (HO-1) protein expression in the lungs. At HA, basal PAP was elevated only in NBS. Treatment with L-NAME revealed a greater increment in PAP in sheep than in llamas. NBS at HA had greater total lung NOS activity, but reduced lung eNOS protein and sGC expression, CO production and HO-1 protein expression than at sea level. In contrast, NBL showed no difference in NO function but an increase in pulmonary CO production and HO-1 expression at HA relative to sea level. Moreover, at HA, whilst total lung NOS activity was lower, pulmonary CO production was higher, in the NBL than in the NBS. In summary, we show that in the llama, enhanced pulmonary CO, rather than pulmonary NO, protects the newborn against pulmonary hypertension at high altitude. This shift in pulmonary dilator strategy from NO to CO is previously undescribed in highland dwellers, and it may give insight into new treatments for pulmonary hypertension.

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