HEAT LOSS AND GAS EXCHANGE: CONFLICTING ROLES FOR THE AIRWAYS AND LUNGS DURING THERMAL PANTING?

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The mammalian respiratory system is essentially divisible into two parts – a conducting airway and a gas exchange portion. In considering thermal panting, a good deal of attention has been paid to the role of the upper conducting airway and the opportunity for heat loss afforded by the nasal, buccal and pharyngeal cavities. My review will tend to concentrate instead on the remainder of the respiratory tract, because it is here that any conflict between heat loss and gas exchange will occur. The conducting airway constitutes anatomical dead space. From a traditional viewpoint thermal panting is considered as consisting only of dead space ventilation. However, this has been shown to be an over-simplistic view as even in steady-state panting gas exchange is liable to be affected. The proportioning of ventilation between the dead space and alveoli has been described by two models – the ‘parallel model’ and the ‘trumpet model’. In the parallel model, air entering the respiratory system is separated into three distinct compartments that communicate but allow for no mixing. In the trumpet model there are two compartments with a variable boundary layer where varying degrees of mixing or stratification may occur. Each model provides a different insight into interactions between heat loss and gas exchange in panting animals. Failure of thermal panting to control body core temperature often triggers a switch to ‘second phase breathing’. This entails larger tidal volumes and inevitably results in hypocapnia and alkalosis. A number of studies across a range of species have examined the effects of CO2 inhalation on breathing pattern in heat-exposed animals. This procedure has tended to replicate the ventilatory pattern seen in second phase breathing when CO2 is inhaled during panting and to accentuate second phase breathing when already present. It is evident that, by its very design, the mammalian respiratory system must impose some degree of compromise between effective heat loss and effective gas exchange.