Panting response in humans during hyperthermia (P)

Endre Sinkovics
Sukhmun Pall
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Panting as a thermoregulatory response

• **Thermal Panting:** Increased respiratory evaporative heat loss (REHL) due to increased respiratory minute volume.

• **First Phase Panting or Thermal Tachypnea:**
  - Decrease in $V_T$ (tidal volume)
  - high frequency (>200 breaths/min)
  - Increase in $V_E$ (minute ventilation)

• **Second Phase Panting or Thermal Hyperpnea:**
  - Increase in $V_T$
  - Reduction in frequency (slower, deeper breathing)
  - Accompanied by $p_a$CO2 changes
Change of ventilator variables due to heat exposure

- Increased minute ventilation
- Slight increase in f
- Significant increase in tidal volume

White & Cabanac (1995)
• Hyperpnea occurs above 38°C suggesting that there is a threshold for changes in minute ventilation $V_E$

White & Cabanac (1995)

**Fig. 4** Ventilatory flow, plotted against core temperatures during 41°C bath immersion, shows the thresholds for hyperpnea at about 38°C. Error bars are omitted for clarity.
Respiratory alkalosis develops in humans

- pH rose
- \( p_a \text{CO}_2 \) decreased
- Bicarbonate decreased
- Lactic acid increased

Gaudio et al. (1968)
Increase in nasal mucosal blood flow

- Nasal mucosal blood flow increases with increasing body temperature

White et al. (1995)

Fig. 2 Nasal mucosal blood flow (NMBF) during 4 min of rest, and during 15 min in a hot bath. Between minutes 4 and 6 the subject was transferred to the bath and the laser Doppler probe repositioned. Each symbol represents the mean of five subjects. Error bars show SE. Hot immersion gave significantly greater levels of NMBF and 15 and 20 min of immersion relative to resting values.*$P < 0.01$. 

Nasal mucosal blood flow increases with increasing body temperature.
Both convective and evaporative respiratory heat loss increase with body $T$. 

Hanson et al. (1974)

**Fig. 3.** Minute volume and convective heat loss for four subjects at three body temperatures in three ambient conditions.

**Fig. 4.** Minute volume and evaporative heat loss for four subjects at three body temperatures in three ambient conditions.
Critiques of Counter-points
Panting as a high rate of breathing

Forster (1952)

Rasch (1991)

FIG. 2. Example of session at 25°C ambient temperature (Tₐ) on subject III to illustrate protocol of sessions and recorded variables. Temperatures were measured with thermocouples. Heat loss was computed on-line.
Investigated ventilatory changes in heat-stressed humans with spinal cord injury. Wilsmore et al. (2006)

- Breathing frequency increases with mean body temperature
- Conclusion that shallow breathing does not occur is unjustified
- Increased breathing frequency is utilized more in injured patients for REHL
Conclusion

- Humans when hyperthermic show:
  - Increase in minute ventilation $V_E$
  - Increase in nasal mucosal blood flow
  - Increase in respiratory heat loss due to both an increase in convective and evaporative heat loss
  - Changes in tidal volume $Tv$ that correspond to the phase of thermal hyperpnea

Humans show a respiratory change to hyperthermia very similar to second-phase panting in other animal species
References

Thank you!