Respiration Physiology (Mammalian Physiology '06)

Acid/Base Respiration Simulation

(Human 6.1, 10/09/06)

Note to outside Skidmore readers. The following maneuvers allow the user create respiratory and metabolic acidosis and alkalosis of any desired amount and to observe the model's attempt to compensate for the disturbance. Simulation of diffusion problems via reduction in lung mean surface area is also introduced.

1) Learning five interventions that are useful in acid-base (& respiratory) simulations

After a brief introductory demo, you will 'experiment' on your own with each of the five interventions below by changing the listed variables (and any appropriate others you may find useful in any Help Info on: screen under View summary of all variables) so as to effect an acid-base disturbance and follow its' compensatory correction.

The techniques to be utilized to effect the desired acid-base disturbance include the following:

a) Infusion - simulates an IV infusion of controlled time, duration and content. [IFMIN, IFVOL, IFBIC]

b) Control of metabolism- controlling metabolism so that it produces more or less acid [BACID]

c) Control of ventilation- controlling ventilation via the use of the artificial respirator [ARTRES, ARVOL, ARRT]

d) Control of atmospheric CO2- controlling atmospheric % CO2 [FCO2AT]

e) Control of lung mean surface area (simulating aspects of emphysema by reducing functional diffusion area) [MSA]

2) Sample simulated acid-base intervention- induction of metabolic alkalosis via infusion of bicarbonate

a) Set tables under View Output: for acid-base output (and use in plotting on a Davenport diagram)

PH, PCO2, BICARB, AVENT, IFMIN

b) Set up the infusion (note order in which variables are set)

1) IFMIN = 60 2) IFBIC = 240 3) IFVOL = 1000 (note: units of IFVOL are ml)

c) run for 1H, 10 (min) between printouts

d) Characterize acid-base status at 0.0, 0.5 & 1.0 hour (by a Davenport plot if available), identify the primary acid base problem and secondary compensations (if present).

3) Problems to work out (for those who desire more structure in setting up see the Hints on the last page)

a) Acid-base simulations - setup, run and characterize the other three possible primary acid-base disturbances and accompanying compensations by

- - designing an appropriate experiment
- - gathering data from *web*-HUMAN
- - plotting at least initial, final & one intermediate state on a Davenport diagram (if available)
- - very briefly analyze each result

b) simulate the loss of lung surface in emphysema by reducing pulmonary membrane surface area available for diffusion [MSA].

- Tables should show arterial & venous PO2, venous & arterial PC02, blood pH and pulmonary vein O2 content.

- Run each simulation for 1D with 4H between printouts.

- Compare, in a table. values obtained at 100, 75, 50 & 25% surface area

- On the basis of the data characterize 1) problems being experienced by the subject including acid-base status and 2) compensations.

- In the 25% run, calculate/ estimate the diffusivity for O2 (D02) and demonstrate that its value shows impaired diffusion (reference-diffusion chapter in West).

Note: a Hints page follows that should only be used if you need more guidance in setting up any of these experiements.

Hints
Run #1 – Make certain IFVOL is entered third as moving it off zero begins the infusion. (note: units of IFVOL are ml)

Run #2 – Use 10 times normal basic acid production, monitor BACID, run for 7H with 1H between printouts, to trace plot 0, 4 and 7 hour values on Davenport plot (if available).

Run #3 – try FO2AT = 0.05, monitor UPH, run 3D at 12 H intervals, how complete is the compensation?

Run #4 – Tables- add VENT, UPH; Run 1H, 15 min. in sequence change ARVOL(750), ARRT(15) and then ARTRES(1). For the loss of lung surface in emphysema, reduce pulmonary membrane surface area available for diffusion [MSA].

Run # 5 – as described

Run # 6 (D02 [diffusivity] estimates) Tables Lung PO2, pulmonary venous PO2, oxygen uptake, Run at 100% for baseline values and at 25% for severe reduction in DO2.