Free airflow through the netted surface of AirNettress and special sheet prevent CO2 retention and enables normal infant breathing even when breathing is possible only through the mattress surface

In a study performed at the Institute of Pulmonology, Hadassah University Hospital, Jerusalem Israel, the mechanical properties of AirNettress were measured and defined with regard to aeration and ventilation. Three sets of experiments were conducted. Two were aimed to measure the aeration properties of the mattress and the third, to measure the resistive properties to airflow through the mattress. All tests were performed on two separate mattresses and each experiment was conducted on a bare, uncovered mattress as well as covered mattresses with a well fenestrated sheet (net sheet) and a regular commercially available cotton sheet (cotton sheet). The following results were measured:

1. The average CO2 elimination was found to be 62.80.1 sec (meanSD) for the mattress. Elimination was only slightly prolonged when the mattress was covered by the net sheet (12%) and by 45% when covered with the cotton sheet. *The result for the mattress is in the range of one minute compared to regular mattresses in which the time required for a decrease from 5% CO2 to 1% CO2 was between 5.5 to 18.7 minutes, depending on the mattress studied (open mesh to foam). When converting the results in our experiment to the same criteria used in the published one the results are still 3-18 times faster in the AirNettress when compared to the standard mattresses. In the same study, the authors reported their findings on the rate of CO2 diffusion through different bedding materials (cotton sheets, blankets etc.) and reported that the time taken for 5% CO2 to disperse to 1% CO2 ranged from 3.2 to 6.5 minutes with the cotton sheet being the fastest. The addition of the net sheet caused an increase of only 30 seconds to the time constant for passive diffusion.*

2. The rate of CO2 accumulation (time constant) was 39.97.0 sec when one side of the headbox was open to the mattress. This was significantly shorter compared to a closed headbox (110.218.7 sec). The rate was the same with the net sheet (33.00.2 sec) and somewhat higher with the cotton sheet (50.70.1 sec).

3. Simulating a breathing infant within the headbox, the maximal attainable CO2 levels were 0.700.01%, compared to 4.750.08%, significantly lower in an airtight chamber. The level did not change considerably by the addition of a net sheet (0.770.03%), but increased markedly with the addition of the cotton sheet (1.230.03%).

The steady state level of CO2 is the result of the balance between CO2 input (from breathing) and CO2 output (by diffusion through the mattress). Hence, steady state levels can range from a maximum of 4.8% CO2, when the headbox is completely blocked to aeration, to a minimum of 0% CO2, when there is no CO2 input or when CO2 input is considerably lower than CO2

output. In this experiment the maximum CO2 concentration was very low for the mattress alone and there was a minimal, insignificant rise with the net sheet. Concentrations below 2% CO2 are considered safe even after a few hours of exposure. Exposure between 2% - 3% CO2 for several hours may cause slight acidosis. At 3% CO2 breathing rate doubles and at 5% is four times the normal rate. Levels of CO2 at 5% and above are directly toxic to the body. According to the US Department of Labor, Occupational Safety and Health Administration (OSHA) the permissible exposure limits for CO2 in the workplace atmosphere are 1% for long exposure durations and 3% for short-term exposure. Similarly, according to the US National Institute for Occupational Safety and Health (NIOSH): "Employee exposure to CO2 shall be controlled so that environmental limit does not exceed 1% for up to 10-hour work shift with a ceiling concentration of 3% not to exceed 10 minutes." In the Colditz study, mentioned above, the authors reported their findings on the rate of CO2 diffusion through different bedding materials and showed that CO2 accumulated to relatively high levels (1.2%-4.8%) with a single bed cover. In the AirNettress experiment the addition of the net sheet resulted in CO2 accumulation under 1% and only with a cotton sheet did the concentration exceed (barely) 1%.

4. H2O/L/sec and only 4% of that was attributed to the measuring device, a result which is considered within the physiologically safe range. Resistance grew a bit with the addition of the net sheet (0.190.01 H2O/L/sec) and significantly with the addition of the cotton sheet (2.350.06 H2O/L/sec).
In this set of experiments the resistance of the material to flow was measured in order to address the question of whether or not AirNettress requires increased work of breathing in order to overcome this resistance. This is an important issue, especially in the newborn and infant age group, since the favorable physical properties of the mattress may not be of use under physiological conditions. A substantial resistance to flow may dictate a need for the generation of significant pressures to overcome it. The resistance measured in the AirNettress is considered well within the safe range allowed by measuring devices designed for infants. Compared to control values, the AirNettress offers negligible resistance and the addition of the net sheet increased total resistance negligibly.

The following conclusions were drawn from these experiments:
The new mattress, AirNettress, was found to have superior properties compared to know values of regularly used mattresses and bedding materials as published in the literature. The new mattress was found to have:

- A fast rate of CO2 elimination
- The ability to clear away any CO2 accumulation, keeping the maximal attainable CO2 level below 1%
- An insignificant resistance to air floz