A STUDY DESIGNED TO ASSESS CO2 ACCUMULATION IN INFANT MATTRESSES

Background

Sudden infant death syndrome (SIDS) is still the leading cause of death for infants aged 1 month to 1 year in developed countries, despite a significant decline in its prevalence stemming from the "Back to Sleep" campaign. One of the possible explanations for the relatively high incidence of SIDS in infants is rebreathing of exhaled carbon dioxide (CO_2) which is trapped in small unventilated compartments (air pockets) near a sleeping infant. In a study published in 2008, researchers found that increasing room ventilation by the use of a fan was associated with a 72% reduction of SIDS[1]. The researchers speculated that their results were consistent with the hypothesis that reducing rebreathing may decrease the risk of SIDS. In a study that was performed in the Pulmonary Laboratory at Sheba Medical Venter and published in Pediatric Pulmonology in 2011 the aeration properties of 6 mattresses (4 advertising to improve airflow and 2 standard) were measured. AirNettress exhibited significantly better aeration properties in dispersing CO_2 and in preventing its accumulation[2]. Lately, new mattresses advertising improved airflow have been marketed.
In this study we measured the aeration properties of 4 mattresses advertising improved airflow and one standard mattress.

Equipment and Methods

Equipment

Four mattresses advertising improved airflow and one standard mattress were studied:

AirNettress consists of a nontoxic polyester net which is stretched over an aluminum frame (without a core) and on it a 6 m"m polyester honeycombed surface.

Comfi consists of a core of dense, woven 6 m"m diameter polyester fibers with a 7 c"m thickness covered with an irremovable layer of polyester.

King coil – Imagine 360 consists of a core made of a criss-cross of rigid polyester fibers with an inner lining of thin polyester and an outer lining of porous polyester both are removable.

Holandia consists of a core made of layer of coated polyurethane which is impermeable to fluid and an additional layer made of thin polyester fibers covered with a layer made of polyester which is removable.

One standard mattress:

Airflow consists of a polyurethane core covered with a polyester layer.

All the mattresses were studied with and without a netted sheet.

Methods

Air flowed into a head box from a cylinder containing 5% CO_2 in air, through an elastic reservoir and unidirectional valves. A reciprocal syringe was pumped at a rate of 48/minute and a volume of 100 m"l (illustration 1). CO_2 concentration was continuously measured with a capnograph (Microcap Plus, Oridion Corp., Israel). Accumulation of CO_2 in a perfectly closed head box has the characteristics of a logarithmic function reaching a stable plateau (max CO_2 level) with a concentration of CO_2 equaling that of the incoming air mixture. In this model, the plateau level is 5% CO_2. The time to reach this level and the rate of CO_2 accumulation, the time constant of the system, are uniquely determined by the ratio of the incoming amount of CO2 to the volume of the head box. As CO_2 is introduced to the head box which is open to the mattress, CO_2 levels start to rise, reaching a plateau level (max CO_2 concentration) which represents the balance of CO_2 production and CO_2 diffusion out of the head box through the mattress surface. In this study CO2 levels were found to rapidly increase within the head box at the onset and thereafter the rate of CO2 accumulation leveled off. When plateaus were reached, mean CO2 level over the last 150 sec of the plateau are reported. In the experiments where CO2 accumulation did not reach a plateau within the five minute recording time, peak CO2 values are reported.

Quality Assurance

All the studies were performed in the Lev Institute, Jerusalem in identical surrounding conditions by Dr Mark Gaides, MD PhD in Pulmonology and Cardiovascular Physiology.

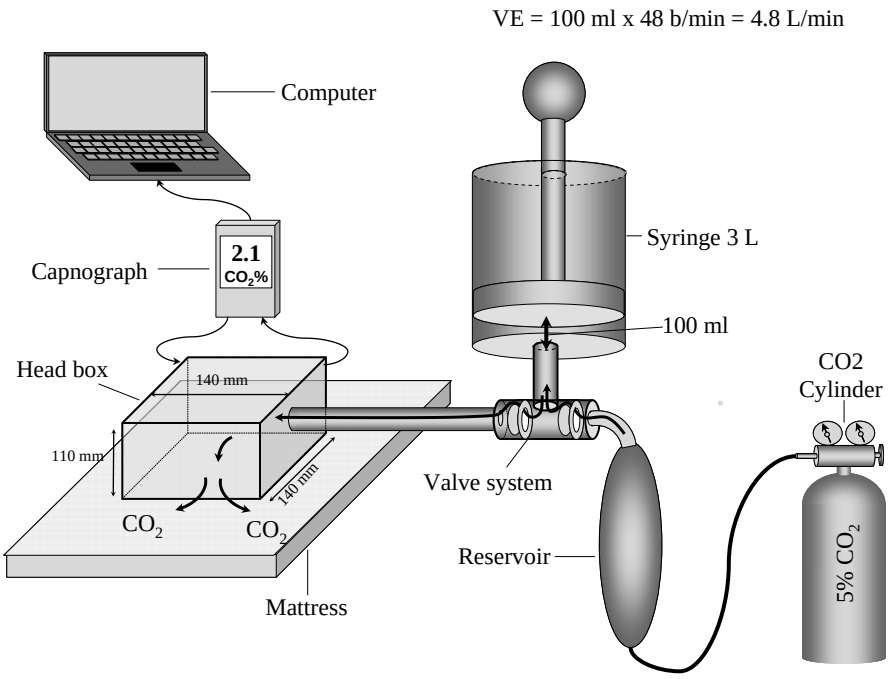

Illustration 1

Results

CO_2 levels were found to rapidly increase within the head box at the onset and thereafter the rate of CO_2 accumulation leveled off. When plateaus were reached, mean CO_2 level over the last 150 sec of the plateau are reported. In the experiments where CO_2 accumulation did not reach a plateau within the ten minutes recording time, peak CO_2 values (*) are reported. Three types of mattresses where tested as reported in the methods: a mattress without a core, three mattresses with a core advertising improved aeration and one standard mattress. Peak CO_2 levels were lowest in the mattress without a core (AirNettress). Among the mattresses with a core the peak levels were low in the Comfi, moderately increased in the King-Coil and highest in the Holandia mattress. In the standard mattress (Airflow) CO_2 levels did not reach a plateau and were the highest. The addition of a netted sheet increased the accumulation of CO_2 by 0.5% to 0.9%

Mattress name	Plateau or peak (*)CO_2 levels
AirNettress	0.4 %
AirNettress with netted sheet	0.9 %
Comfi	1.1 %
Comfi with netted sheet	1.8%
Aminach King coil	2.0 %
Aminach King coil with netted sheet	2.9 %
Holandia	3.8 %
Holandia with netted sheet	4.3 %

Airflow	4.4 % (*)
Airflow with netted sheet	4.6 % (*)

Table 1

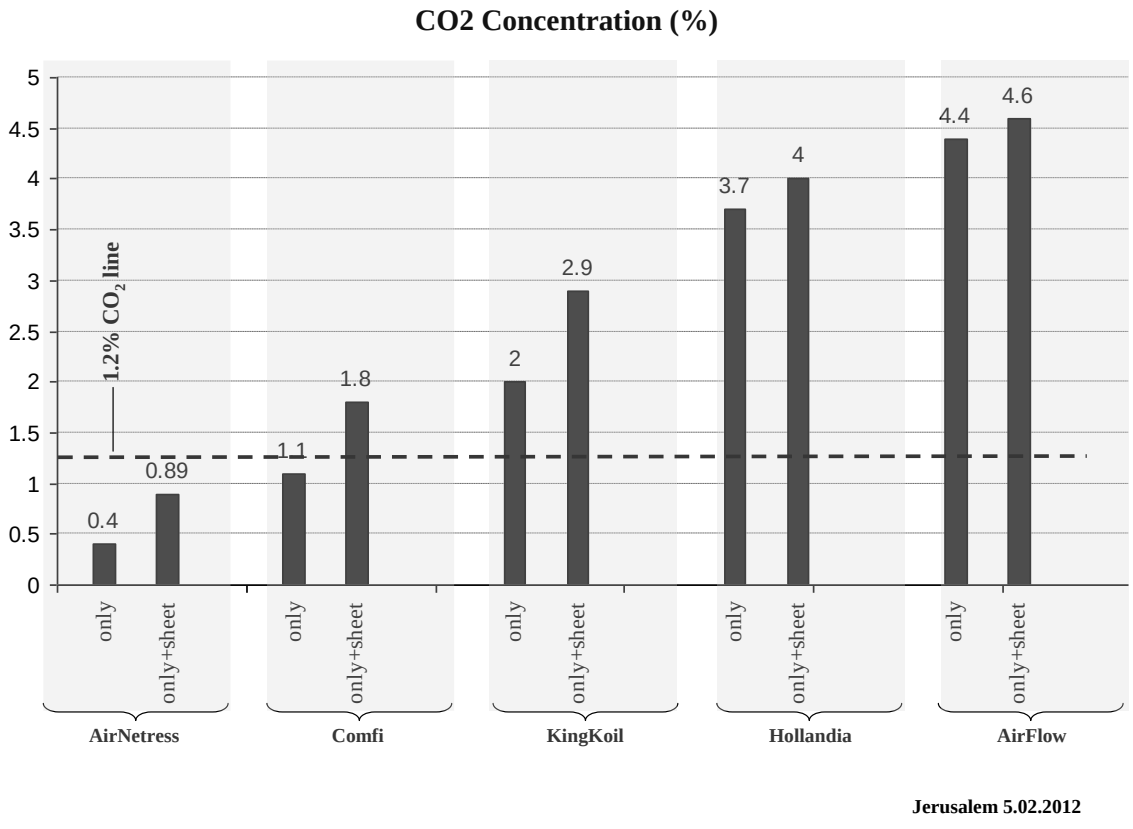

Figure 1

Conclusions

In this study, using a mechanical breathing model of an average 6 months old infant the maximal CO_2 levels were lowest in AirNettress and below 1.2%. In our experiments, maximal CO_2 concentrations for the mattress alone and the mattress covered with the net sheet were below the 1.2% limit. These CO_2 levels are considered safe environmental conditions according to the National Institution for Occupational Safety and Health (NIOSH)[3].

These characteristics are important for infants during their first months of life, mainly in situations when breathing is possible only through the mattress as in prone sleep or when the face is covered by a blanket or pillow and in high risk infants. Regarding the other mattresses all were above the 1.2% limit after being covered with a netted sheet but were superior to the standard mattress.

Mark Gaides, MD, PhD, Breathing and Cardiovascular Physiology

References

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2. Bar-Yishai E, Gaides M, Goren A, Szeinberg A. Aeration properties of a new sleeping surface for infants. Pediatric Pulmonology 2011; 46:193-198
3. Criteria for a Recommended Standard: Occupational Exposure to Carbon Dioxide. DHHS (NIOSH) Publication No. 76-194: August 1976