1-1-2012

Phonic respiration and Its impact on carbon dioxide rebreathing in respiratory protective devices

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Abstract

Abstract presented at the International Society for Respiratory Protection Sixteenth Biennial Conference, 23-27 September 2012, Boston, United States

Keywords

its, devices, respiration, protective, phonic, respiratory, breathing, re, dioxide, carbon, impact

Disciplines

Arts and Humanities | Life Sciences | Medicine and Health Sciences | Social and Behavioral Sciences

Winner of the 2012 ISRP Americas Section Student Research Award for Best Abstract using the NIOSH Anthropometric survey data set:

Phonic Respiration and its Impact on Carbon Dioxide Re-breathing in Respiratory Protective Devices (Pilot Study)

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Background: Carbon dioxide (CO_2) re-breathing has been recognised as a key concern regarding respirator use and is related to increased respiration, heart rate, breathing discomfort, anxiety, headache, impaired cognitive function, and in higher amounts asphyxia or death. Several studies have examined CO_2 levels in respiratory protective devices (RPDs), however no previous investigations have evaluated the relationship between CO_2 inhalation and phonic respiration (breathing during speech).

Methods and Approach: A total of 22 participants (8 females) volunteered for the pilot study. Participants performed a graded exercise test on a cycle ergometer that increased in resistance every 5 minutes. During the third minute of each stage participants read aloud a prepared text. Measures of expired ($PECO_2$) and inspired CO_2 ($PICO_2$), heart rate (HR), peak inspiratory air flow (PIAF) and dyspnoea (breathing discomfort) were monitored.

Results and Discussion: A paired sample t-test was performed to compare $PICO_2$ within the two breathing conditions (normal and phonic respiration). The variables were calculated across all six workloads (rest, 75W, 100W, 125W, 150W and 175W) (alpha was set at 0.05). Significant differences between the two breathing conditions, at rest and each exercise workload were found (see Table 1). During normal respiration, $PICO_2$ was generally below 2%, however was present at higher levels during phonic respiration. The highest $PICO_2$ was obtained at rest, and was observed to decrease during increased oxygen uptake (workload) suggesting that the breathing frequency and flow rates are a decisive factor in CO_2 re-breathing in RPDs.

Preliminary Conclusions: The results showed that phonic respiration in respirators contributed to significantly higher levels of CO_2 re-breathing that was often beyond the design standards recommended by Standards Australia (1%). Further research into the occurrence of CO_2 re-breathing in RPDs and its impact on workers who inevitably wear them for prolonged periods is in progress.

Table 1: Carbon dioxide inspired at rest and exercise for normal and phonic respiration (speech)

	Rest (n=17)		*75 Watts (n=10)*		*100 Watts (n=17)*		*125 Watts (n=15)*		*150 Watts (n=7)*		*175 Watts (n=2)*	
	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S
$PICO_2$	1.61	2.46*	1.25	2.02*	1.12	2.08*	1.19	1.99*	1.07	1.97*	0.83	1.97*
SD	0.41	0.51	0.37	0.63	0.27	0.56	0.39	0.56	0.51	0.69	0.25	0.30

$PICO_2$, Percentage Inspired Carbon Dioxide, SD, Standard Deviation, NS, No Speech, S, Speech
*$p<0.05$.