N003

Mass Balance Mathematical Model of Gas Exchange with CBRN Protection Devices

Noam Gavriely, MD, DSc

Department of Physiology and Biophysics, Rappaport Faculty of Medicine,
Technion – Israel Institute of Technology, Haifa, Israel.
Tel: +972-54-661337 e-mail: noam@ohkmed.com

ABSTRACT

Background: Levels of the respiratory gases, O_2 and CO_2, are well known limiting factors in assuring safety of CBRN respiratory protection devices. This study presents a mass-balance mathematical model of gas exchange while donning a two-compartment gas mask.

Method: The model consists of a mouth-nose compartment and an additional external compartment that is either a face compartment or a hood enclosure. The model presented herewith consists of a purified air inlet into the External Compartment (see Figure), a Secondary Inspiratory Valve between the compartments and an Expiratory Valve. A computer program was developed based on a set of mass-balance equations that predict the concentrations and transport of CO_2 under any desired set of respiratory conditions. **Results**: First the model was validated with NO Leak (Left Figure, below) based on experimental measurements of flows and gas concentrations. The validated model was then used to evaluate the effects of an air **Leak** from the mouth-nose compartment (Right Figure).

Conclusions: This validated model can be used to predict gas concentrations in CBRN protective devices under variety of subjects' respiratory maneuvers, tidal volumes, dead space and metabolic rates.