Fireground Use of an Emergency Escape Respirator

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BACKGROUND

Firefighters who become lost, disoriented, or trapped in a burning building die of smoke inhalation after running out of air in their self-contained breathing apparatus (SCBA).

An emergency escape device has been developed: attached to the firefighter's mask in place of the air tank regulator, it filters out particulate matter and a number of hazardous components of smoke, including carbon monoxide (CO), providing additional time to escape after the firefighter runs out of SCBA air.

The purpose of this study was to field-test the device under realistic fire conditions to ascertain if it provides adequate protection from CO, and to examine firefighters' impressions of the device and its use.

METHODS

A wood-frame house being used for a live-burn fire department training exercise was fitted with multi-gas monitors placed at the floors and ceilings. Levels of carbon monoxide (CO), oxygen, and hydrogen cyanide (HCN) were continuously recorded electronically.

With informed consent, firefighters wearing the emergency escape respirator instead of their usual SCBA entered the burning structure and spent exactly ten minutes breathing through the device.

A breath CO analyzer was used to estimate (+/- 3 ppm) each subject's carboxyhemoglobin level immediately upon exiting the building, and each firefighter was asked for general impressions of the device.

The study was approved by the Yale IRB.

RESULTS

Thirteen male firefighters were enrolled (mean age 42.5 yrs, mean weight 94 kg). Enrollment was dictated by the number of respirators available for testing.

4 subjects rested during the ten minutes in the burn building

9 subjects exercised during the ten minutes: walking, pulling ceilings, breaking windows, etc.

Meter readings confirmed realistic fire conditions in the rooms where the study firefighters were located:

Ambient CO readings:
Floor: mean 546 ppm
Ceiling: minimum 769; most readings exceeded 1000 ppm limit of meters
(Permissible exposure limit: 50 ppm)

Ambient HCN readings:
Ceiling: mean peak HCN 20.8 ppm
(Permissible exposure limit: 10 ppm)

Ambient oxygen readings:
Floor: mean 20.4%, range 19-20.9%
Ceiling: mean minimum 13.2%

Total subjects' mean carboxyhemoglobin level immediately upon exiting: 1.15% (range 0.82-2.1%)
Difference between means (activities during ten minutes) were not significant.

No subjects reported any concerns or problems using the device while in the fire building. Several noted a slight difference in breathing mechanics (not a positive-pressure device like their usual SCBA), but did not feel this was a limitation of the respirator.

All 13 subjects expressed interest in carrying the device while on duty.

LIMITATIONS

Only carboxyhemoglobin was tested. The ability of the respirator to protect firefighters from other toxins was not tested. (The manufacturer reports adequate protection from acrolein, hydrogen cyanide, and hydrogen chloride.)

The number of subjects enrolled was limited by the number of respirators available.

CONCLUSIONS

The emergency escape device provides excellent protection from CO in realistic fire scenarios with substantial exposure to toxic gases.

Ambient oxygen levels at the floor are adequate to sustain life, even during active fire conditions.

The firefighters studied had a positive impression of the device and its use.

Funding: The emergency escape respirators (Last Chance Rescue Filter) were donated by the manufacturer, Essex PB&R, St. Louis MO.

The breath CO analyzers (COB-I) were loaned by the manufacturer, FSP Instruments, Inc., Hoboken NJ.

Neither company had a role in collecting, analyzing, or reporting the data.

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