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A Novel Mask for Protection of Health Care Providers Against Toxic N_2O Gas in the Operating Rooms and Evaporates of ^{131}I in Nuclear Medicine Hotlabs of Developing Countries

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Abstract: The aim of this research is to introduce a novel mask which can provide efficient protection against the toxic N_2O gas and ^{131}Iodine encountered in the operating room and nuclear medicine hotlabs. The mask is designed in four layers to trap the toxic gases and prevent the inhalation of toxic agents. The preliminary data indicate a 75% protection against ^{131}Iodine evaporates and a 70% protection against N_2O gas. This mask shows promising results and can be used as a protective measurement for the health care providers in the developing countries.

Key words: N_2O, ^{131}I, mask, protection, toxic, agents

INTRODUCTION

Toxic gases are among the most frequent occupational hazards specialists in various fields of medicine encounter. Two of these toxic agents include the N_2O gas, widely used as an inhalational anesthetic source in the operation roomsand evaporates of ^{131}I in nuclear medicine hot labs (Alavi *et al*., 2015). The ^{131}Iodine is wildly used in differentiated thyroid cancer treatment. Differentiated thyroid carcinoma is usually managed by near-total or total thyroidectomy followed by ^{131}I ablation of any remnant thyroid tissue. For this purpose, whole body ^{131}I imaging has been used for the follow-up of Differentiated Thyroid Carcinoma (DTC) for decades (Haghighatafshar and Khajehrahimi, 2015). As radioiodine evaporates, the aim of this study was to introduce a novel and cost efficient mask which can reduce the risk of inhalation of these toxic materials when encountered. This mask is especially useful in the developing countries which lack the highly efficient ventilation systems.

MATERIALS AND METHODS

We made a 4 layer mask consisting of the following layers from inner out: a layer of N95 mask (1805, 3M company, St. Paul, USA), silver nanoparticles on a sterile gauze base as the antibacterial layer, sterile gauze imbrued with bentonite as the hydroabsorptive materialand another sterile gauze layer consisting of colemanite mineral as the radioprotective layer.

The radioprotection effectiveness of the mask against ^{131}Iodine evaporates was assessed by placing the mask over an open source containing 50 mCi of ^{131}I for 20 min. A simple N95 mask (which is frequently used by the nuclear medicine technologists while preparing the radioiodine in the hotlabs for administration to the patients) was also put over another open source with the same amount of activity for the same period of time. The absorbed amount of radioiodine evaporates by the two masks were then calculated using a well counter (CRC®-25R dose calibrator, Capintec Inc., NJ).

To evaluate the efficacy of the mask for protection against the N_2O gas, a constant flow of 3 L^{-1} min of N_2O (as the routine administered dose in the operating rooms), was maintained into a cube glass box with two holes in its opposite facing walls, one for entrance of the gas and another one as the exit site. The mask was placed over the exit site with its periphery sealed to prevent gas leakage. Using a Bacharach N_2O Monitor 3010 (Bacharach Inc., New Kensington, PA), with gas detection based on an

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infrared-absorption principle, the amount of exiting gas was measured at 10 cm distance from the hole. The same procedure was repeated with a N95 mask over the exit hole. The room temperature was between 24-26°C at the time of measurements. Both tests were repeated 20 times and the results were averaged.

RESULTS

For the radioiodine evaporates protection, the well counter determined the averaged amount of ^{131}I activity trapped in the invented mask to be 0.46 mCi while the activity in the N95 mask was 0.12 mCi which shows a 4 fold protection.

The mask also revealed to be very effective against N2O with 70% protection (5839 ppm of N2O crossing the normal mask against 1751 ppm in the case of the invented mask).

DISCUSSION

Protecting patients and healthcare workers from harmful ionizing radiation, has been an important concern (Haghighatafshar *et al*., 2015). There have been many previous reports on the toxicity of N_2O gas for the personnel of the operating room, especially the anesthesiologists who frequently inhale it. Some of the most important effects include: decreased fertility, increased risk of spontaneous abortion, fetotoxicity and increased rates of congenital malformations (Sanders *et al*., 2008). The exposure rates are higher in the operating rooms of developing countries which lack highly efficient scavenging and ventilating systems (Maroufi *et al*., 2011).

The exposure rates of nuclear medicine technologists who prepare the ^{131}I, to be administered to the patients with thyroid cancer, to the evaporates of radioiodine is also high. Although, no specific data exist in this regard, we have frequently observed this issue in these personnel in our country, again due to lack of advanced ventilation systems and their exposure to high doses of radioiodine in open sources.

Exposed personnel and specialists in both fields usually use a regular surgical mask such as N95 mask for the least protection they can get. Therefore, the main motivation behind inventing this mask was to introduce a simple, cheap, yet efficient way to minimize the inhaled amount of daily inhalation of these toxic materials, especially in the developing countries where providing the resources for the expensive scavenging and ventilation systems is not possible.

CONCLUSION

The materials used in this mask are both cheap and readily available and the mask can be easily made. All of the mentioned qualities are favorable for the developing countries. Although, more advanced research is required, the preliminary results indicate that this mask is highly efficient both against N_2O gas and radioiodine evaporates and can be useful in the operating room and nuclear medicine hotlabs specially in the developing countries.

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