

The Use of Respirators in the Workplace

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DR. JAMES A. SCHNEID (*Occupational Health Physician, Maine-Dartmouth Family Practice Residency*): The safety and appropriateness of an employee wearing a respirator are issues that family physicians, especially those involved in occupational medicine, will commonly have to deal with. Wherever we may practice, our patients may ask us to certify that it is medically safe for them to be wearing respirators in the workplace.

Respiratory equipment may be needed in a variety of different situations. Miners or workers who are cleaning asbestos out of public buildings may need to wear respirators or air-purification equipment to be protected from particulate matter over long periods. Fire and police personnel, as well as industrial emergency workers, may use respirators for short periods in battling fires or toxic chemical spills. Others may wear air-purification equipment or respirators for brief periods to protect themselves from intermittent solvent or chemical exposures during an engineering process.

Today's Grand Rounds discussion emphasizes the importance of family physicians understanding the environment in which their patients work, describes the types of respirators available and medical conditions that bar employees from wearing protective respiratory equipment, and discusses preventive respiratory programs for the workplace.

CASE PRESENTATION

A 35-year-old man with asthma for approximately 17 years requested permission from me as plant physician at a local computer production company to wear a self-contained breathing apparatus (SCBA). His usual position there was that of production supervisor, a job that required prolonged periods behind a video display terminal but involved no manual labor skills and no exposure to smoke or particulate

matter. As part of an emergency preparedness plan in the plant, he was already certified in cardiopulmonary resuscitation and wished to be certified to wear a respirator for up to 30 minutes to help control fires or chemical spills in emergency situations.

The patient's medical history was devoid of any serious medical problems except the recurrent asthmatic attacks. He had never been hospitalized, but had had several emergency room visits for these attacks. During the past year he had controlled his symptoms well by intermittent use of an albuterol inhaler, two puffs four times per day, as needed. The patient reported that his asthma worsened with severe emotional stress and in the spring and fall when airborne pollen allergens were more prevalent. The patient had no allergies, had no alcohol or substance abuse problems, and did not smoke. Several relatives had asthma as well. He was a volunteer fireman and had already been wearing respirators for emergency work with the local fire department, which had never required medical permission to do so. He expressed concern that if he was not allowed to use a respirator at work his status with the volunteer fire department might be jeopardized.

His physical examination was normal except for uncorrected visual acuities of 20/100 in the right eye and 20/200 in the left eye. With contact lenses or glasses these corrected to 20/20. He appeared quite comfortable and was not dyspneic. Ear, nose, and throat as well as heart and lung examinations were normal. His pulmonary function tests were normal with forced vital capacity (FVC) 3.16 L, percent predicted 93.5%; forced expiratory volume in 1 second (FEV₁) 2.65 L, percent predicted 95%; FEV₁% 84%, percent predicted 101.5%.

The patient also brought a note on a prescription blank from his family physician stating that it was safe for the employee to wear a respirator. When I called this physician, he was a little embarrassed and obviously had not expected to be questioned. The physician admitted that he had really just been acting as a stenographer for the patient, writing down on a prescription pad what was asked of him.

Some time was then taken with the patient explaining that respirators in this instance were being used in a crisis situation where a tremendous amount of emotional stress

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would be applied to the individual. It was pointed out to the patient that although he was medically stable in recent times, under moments of stress in the past he did have exacerbations of respiratory symptoms. In an emergency his functional capacity would be very important to the safety and health of others. In addition, the increased work of wearing a respirator, secondary to its weight, would exacerbate an already unpredictable pulmonary situation. The employer arranged testing facilities with the state fire marshall simulating an actual emergency situation. The employee was required to wear his respirator and crawl through a smoke-filled maze of tunnels constructed specifically to test ability to withstand on-the-job work loads and conditions. During the test the employee did experience an exacerbation of his wheezing, which was disabling. It was advised that he not be certified for wearing a self-contained breathing unit for emergency situations. This decision did not affect his present employment, and he certainly understood the logic of why his wearing a respirator would be potentially unsafe in an emergency.

CLINICAL APPROACH

I want to point out the dilemmas a responsible employer encounters in a case such as this. On the one hand, the employer does not want to encourage or permit an employee with a medical condition to do a job that would harm him or increase risks for fellow employees. On the other hand, the employer does not want to unfairly discriminate against individuals because of medical history. The dilemma is similar to another frequently encountered: when is it reasonable for an individual with a seizure disorder to operate machinery or an automobile? Recently, patients with insulin-dependent diabetes have won less-restrictive driving licenses by arguing previous regulations were unnecessarily discriminatory. One wants to be fair to the employees' rights and yet still be medically safe.

ROBERT MULLEN (*Environmental Health and Safety Engineer*): Respirators are fundamentally a bad solution to a hazardous problem. When someone wears a respirator, it should be as a "solution of last resort." Oftentimes respirators are selected with very little knowledge about the environment in which the wearer will be. I would like to see physicians more frequently question sending people into certain environments at all, even with respirators. The wearing of a respirator often gives an employee a false sense of security and protection.

The physician should ask the employer whether there are any industrial hygiene data on a particular environment. Will the employee be exposed to particulate matter, solvents, or materials that are potentially carcinogenic, such as asbestos? More important, employers must be chal-

lenged to provide samplings of the environment so that they are aware of the levels of potential irritants or toxins to which employees might be exposed. If the levels approach the threshold values established by the Occupational, Safety and Health Administration (OSHA), then the physician has to question the use of the respirator. The appropriate choice of respirators with various substances is found by consulting the chemical exposure tables of the NIOSH-OSHA *Pocket Guide to Chemical Hazards*.¹

From the safety engineering point of view, it may be impossible to make the workplace even marginally safe with respirators. Industry may say, "Put this person into the environment," and the physician may have to say, "It is impossible. I can't put the person in with any kind of reasonably safe equipment. The industry will have to change the environment." Sometimes the physician must put his or her reputation on the line and take a stand.

There are often preventive actions that can be taken short of using a respirator. What means are available to control hazardous chemical or particulate matter exposures in the workplace? First, employers can try not to have toxic substances in the workplace by substituting, whenever possible, less toxic substances that will still do the job. Second, employers can engineer the chemical or particulate matter out of the job, through ventilation, enclosure of the process, or otherwise keeping the noxious substances away from the people using them. Third, employers can implement administrative controls, such as controlling the exposure time or the time of operation runs, rotating shifts, and rotating jobs, so that employees spend limited amounts of time in areas that are unhealthy. Only if all these measures are impossible should we have to resort to personal protective equipment such as respirators, suits, or gloves.

DR. SCHNEID: Let's take a few moments to talk about various respirators that are available in the workplace environment.

TYPES OF RESPIRATORS

SANDRA BISSET (*Environmental Health and Safety Engineer*): By definition, a respirator is a device worn over the mouth or nose to protect the respiratory tract from harmful contaminants or for provision of adequate oxygen. Respirators are divided into (1) air-purifying respirators, and (2) atmosphere-supplying respirators. Air-purifying respirators may be powered or nonpowered. Powered units contain a blower that moves air through a filtering material. These units can weigh 5 to 15 lb, but otherwise do not add substantially to the work of respiration. Nonpowered devices require the individual to generate sufficient inspiratory effort to draw air through the filtering material and do add to the work of respiration. These air-purifying respi-

rators are most often used for particulate matter, and respiratory fatigue during heavy exertion is the major limitation. These respirators have a standard protection factor for a particular substance and may not be safe if the environment changes or if breaks in the face-mask seal occur. For example, a respirator with a protection factor of 10 would reduce an ambient concentration of 30 parts per million (ppm) trichloroethane well below the OSHA permissible limit of 10 ppm to approximately 3 ppm in the improved air. If the employee is uncomfortable and cracks the seal or if there is not a perfect face-mask seal during inspiration, however, ambient air containing hazardous substances may enter the respirator, bypassing the filtering device.

The second type of respirator can be either a self-contained breathing unit or a continuous flow respirator utilizing an air line from a remote source. These respirators maintain positive pressure within the mask and utilize a regulator that supplies air to the mask with inhalation. Self-contained units add little to the actual work of respiration, but weigh up to 40 lb and thus add to the total work effort of the user. As a result, heavy respirators can increase energy requirements and oxygen consumption, which is associated with increased minute ventilation. This self-contained breathing apparatus has other drawbacks. Because of the tight-fitting mask, there is a serious problem of heat buildup near the user's face, which irritates the skin. The mask straps constantly pull hair out. Many times, just ensuring an adequate tight fit of the mask is a difficult problem. Because of the importance of a tight fit of these full-face masks, employees with glasses usually cannot wear these self-contained breathing units. There just is not room. Respirators using a remote air source have the obvious drawbacks of needing to maintain an intact line and restricting movement to the length of the line.

Finally, the dead space of a respirator, reflecting the amount of expired air that must be rebreathed before fresh air is obtained, tends to cause increased ventilation. At least one study has shown substantially increased ventilation with a full-face respirator, a type that can have a large effective dead space.²

MEDICAL SURVEILLANCE

DR. SCHNEID: The literature describing acceptable medical surveillance in the workplace sets forth some guidelines, but at the present time there are no federal regulations that make the physician's decision on medical certification for respirator use simple. An individual decision must be made by the examining physicians based on their best judgment.³ Physicians examining patients for respirator use must take a detailed medical history, includ-

ing psychiatric, pulmonary, and cardiovascular review of systems.

Psychiatric disorders or other personality traits may prevent safe respirator use.⁴ People with emotional instability in the face of stress and those who are claustrophobic when wearing a face-confining mask may need to be excluded. Workers who are unable to understand the purpose and proper use of respirators should not be permitted to use them.

Although it is common practice to exclude a candidate with abnormal pulmonary function testing from respirator certification, there are as yet no available studies to validate this approach as useful. A recent study indicated that short-term respirator use may be well tolerated by those with mild obstructive disease as well as by those with normal lung function.⁵ No studies are available to show at what stage of pulmonary obstructive disease individuals will find respirator wear intolerable. One author has studied the general responses of candidates while wearing respirator protection in a simulated work situation.^{6,7} Although time-consuming, this assessment of safety seems to be best for difficult cases.

For those individuals who must wear a respirator all day, rather than just for emergencies, a significant sputum-producing cough or the need for inhaled bronchodilators at regular intervals would make certification impractical. Some individuals with preexisting lung impairment, such as asthma, may be sensitive to small levels of occupational agents that are well below the threshold values previously discussed. Asthmatics whose respirator difficulties are aggravated by high stress should not be respirator certified for emergency situations.⁴

The cardiac evaluation of an employee depends on his or her past medical history, the predictability of the workload, and the type of respirator being used. The person with unstable angina, uncontrolled hypertension, or recent myocardial infarction should be excluded based on the unpredictability of the medical situation.

The added work of breathing from respirators is small and in several studies could not be detected. Oxygen consumption may double, but this is probably not of clinical significance in a stable medical situation.⁸ Several studies have shown that given a stable workload, the heart rate does not change with wearing a respirator.⁵

Because of the added weight, the work demand changes when a self-contained breathing unit is utilized. In addition, in many of those situations in which the SCBA is used, such as fire fighting, the worker also must wear 10 to 15 lb of protective clothing. The combination of the stressful work, heat, and increased weight will increase cardiac demand.⁹

A few specific medical conditions need brief mention. Diminished sensations (hearing, vision) in an employee will result in reduced respirator safety. Contact lenses are not

continued on page 27

continued from page 23

recommended for use with respirators. If there is exposure to the ambient environment, a corneal erosion may ensue. Loss or misplacement of a lens during respirator use may prompt the wearer to remove the respirator.

Although inhalation of toxic materials through a perforated tympanic membrane is possible, studies have shown this not to be of clinical importance.¹⁰

Structural abnormalities of the face, as well as eyeglass frames, beards, and so on, may make it difficult to pass a "fit test."

MR. MULLEN: Most employers feel that the only way to decide whether a mask has an adequate facial seal is to perform quantitative fit testing. This involves sending an employee wearing a respirator into a special booth, introducing a test oil mist, and monitoring the mist levels inside and outside the face piece to detect any leakage. Other employers will just do quantitative fit tests, which involve exposure to either irritant smoke or isoamyl acetate (banana oil) to determine whether the employee can detect the substance's presence through a respirator. Employees who have facial hair and beards are many times excluded from the process based on fit testing.

RESPIRATOR PROGRAM

We talked previously about the physician having some responsibility in determining whether it is safe for the employee to be in a particular environment with respirators as a backup. I have never known an employee yet who thinks respirators are comfortable; at best, respirators are seen as a necessary evil. Given that respirators must be used in certain work circumstance, there are important things that companies can do to make sure that employees are using the equipment safely. As mentioned previously, I think it is important that the employer have ongoing sampling of the environment and have a monitoring program for evaluating airborne contaminants to make sure that they are well controlled and within OSHA limits. The company should also take responsibility for choosing the proper respirator that fits the employee comfortably. There should be an ongoing educational system to make sure that employees are trained well in the use of the equipment and that equipment is taken care of properly. Maintenance should include checking filters and straps for deterioration and cracks as well as frequent cleaning.

DISCUSSION

DR. SCHNEID: This case illustrates the difficult process and factors to consider in evaluating whether an individual

employee can use a respirator in the workplace. Although this employee had acceptable pulmonary function tests, his history of ongoing asthma attacks, especially when under stress, and failed work-site simulation led to the recommendation of his not using a respirator during emergencies.

A comment needs to be made about the occupational physician's role in preemployment evaluation as compared with preplacement evaluation. For preemployment, physicians should take a role in ensuring that patients are not refused employment based on some medical disability. For preplacement, physicians should ensure that medical evaluations are done to place employees safely in proper positions within the company. For example, ideally a physician should decide whether respirators are safe or prudent for an individual employee, and if they are not, recommend that the company provide a more appropriate employment position.

I also think that the occupational physician has a role in communicating with other primary care physicians. In this particular case the reasons for denial were based on the extremely stressful situation the employee would be in while wearing a respirator, his past experience of asthma attacks in those situations, and simulated testing. Direct communication with the primary physician will prevent discrepant evaluative reports from various physicians involved in the patient's care.

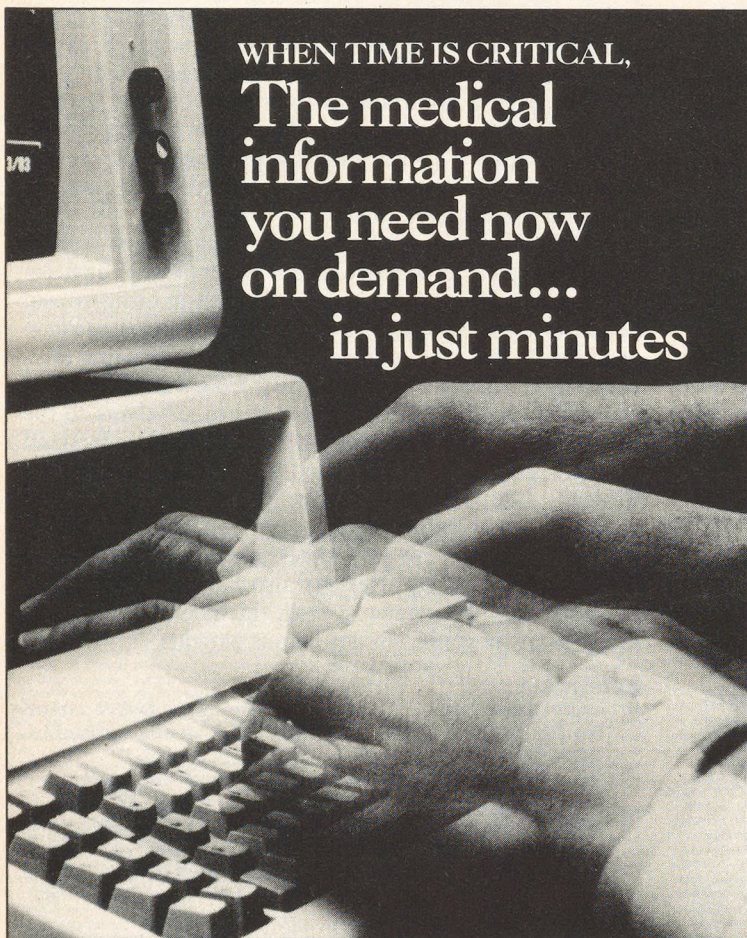
The final challenge for us as family physicians is to be more involved in understanding our patients' work environments. One doesn't have to be an expert in occupational health to visit the work site and make commonsense suggestions. To see what our patients are experiencing is as valuable as reading a list of toxicities from a chemical data sheet. For us to evaluate employees adequately as to the safety of wearing respirators, we must initially understand whether respirators are the ideal solution to the situation. Ethically, we don't want to be put in the position of condoning an essentially unsafe situation.

Physicians must not only understand the medical criteria for safe respirator use, but also have an idea of the patient's work environment. With this knowledge we can safely evaluate respirator use by our patients.

References

1. NIOSH/OSHA Pocket Guide to Chemical Hazards. DHEW publication No. (NIOSH) 78-210. Cincinnati, Ohio, NIOSH Publications, 1985
2. James R, Dukes-Dobos F, Smith R: Effects of respirators under heat/work conditions. *Am Ind Hyg Assoc J* 1984; 45:399-404
3. General Industry Standards, OSHA 2206, 29CFR 1910.134. Government Printing Office, 1983
4. Morgan WP: Psychological problems associated with the wearing of industrial respirators: A review. *Am Ind Hyg Assoc J* 1983; 44:671-676
5. Hodous T, Petsonk L, Boyles C, et al: Effects of sudden resistance to breathing during exercise in obstructive lung disease. *Am Rev Respir Dis* 1983; 128:943-948
6. Raven PB, Davis T, Shofer C, Linnebun C: Maximal stress test

- performance while wearing a self-contained breathing apparatus. *J Occup Med* 1977; 19:802-806
7. Morgan WP, Raven PB: Predictions of distress for individuals wearing industrial respirators. *Am Ind Hyg Assoc J* 1985; 46:363-368
 8. Gee JBL, Burton G, Vassallo C, et al: Effects of internal airway obstruction on work capacity and pulmonary gas exchange. *Am Rev Respir Dis* 1968; 98:1003-1012
 9. Raven PB, Dodson A, Davis TO: Stresses involved in wearing PVC supplied air suits: A review. *Am Ind Hyg Assoc J* 1979; 40:592-599
 10. Ronk RA, White MK: Hydrogen sulfide and the probabilities of "inhalation" through a tympanic membrane defect. *J Occup Med* 1983; 27:337-340

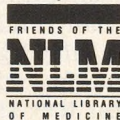


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