An Ounce of Prevention Is Worth a Pound of Cure

The words of Benjamin Franklin have passed the test of time. Several authors have reported an increase in respiratory morbidity in respiratory therapists (RTs) after they enter the profession.[1–4] RTs are exposed to infectious and other aerosols while performing their daily tasks. A few years ago the severe acute respiratory syndrome (SARS) epidemic, and more recently the influenza H1N1 epidemic, brought renewed attention to the risk incurred by healthcare providers participating in droplet/aerosol generating procedures.[5,6] Gralton et al recently performed an extensive review of the literature regarding particle size of aerosol/droplets and infectivity.[7] They concluded that infectious aerosols consisting of mainly large particles also have small ones, making them contagious not only by contact but also by aerosolization. Also, the need to reduce exposure of aerosols generated while providing nebulizer treatments was previously underscored because of the teratogenic risk of ribavirin and pentamidine.[8–10]

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In this issue of Respiratory Care, McKeown et al report an original bench study about a modification of a high frequency oscillator circuit to prevent risk of infection of healthcare providers.[11] The original circuit has a non-heated filter that collects condensate because the circuit is humidified. This leads to malfunction of the ventilator; therefore, the manufacturer recommends daily replacement of the filter. This maneuver has 2 undesirable consequences: the first is lung derecruitment, and the second is the exposure of healthcare providers to the potentially contagious aerosols. The authors modified the circuit by replacing the original filter with a heated expiratory filter. They demonstrated that tidal volume and filter efficiency remained unchanged after the modification was done and the filter was used for 48 hours.

The study was well executed, but it is important to be aware of its limitations. The first one is the in vitro nature of the study, because these studies tend to oversimplify a complex biological model. In vitro testing also oversimplifies the in vivo variability of human response.[12] These results could be validated in a respiratory distress animal model. The second one is the lack of safety data. This is an important aspect, since this modified circuit is intended for human use. However, a large number of patients might be needed, due to the very ill nature of patients requiring high frequency oscillator support.

The question of exposure and respiratory morbidity is not a new one for the RT. In 1989, Kern et al reported that RTs had an odds ratio (OR) of 6 (95% CI 2.0–10.4) of developing asthma after entering the profession, when compared to other healthcare providers (physical therapists and radiologic technologists).[1] These results were later confirmed by Christiani et al, who surveyed RTs in the state of Massachusetts and reported that 7.4% of RTs developed asthma after entering the profession, compared to 2.8% of controls (physical therapists and physical therapy assistants).[2] RTs were 2.5 times more likely to develop asthma (95% Cl 1.6–3.3) after appropriate adjustments were made. The authors speculated that exposure to infections, irritants, and aerosols could be responsible for these findings. Dimich-Ward et al surveyed RTs and compared their responses to those of physiotherapists and found that the former had over twice the risk of respiratory morbidity (ie, being woken by dyspnea, having wheeze, asthma attacks, and asthma diagnosed after entering the profession).[3] More recently, Delclos et al gained more insight into possible causes for this increased pulmonary morbidity.[4] They surveyed a group of physicians, nurses, occupational therapists, and RTs and found that the diagnosis of asthma after entering the profession was associated with some activities such as cleaning medical instruments (OR 2.22, 95% CI 1.34–3.67) and administration of aerosolized medications (OR 1.72, 95% CI 1.05–2.83). Their questionnaire also inquired about bronchial hyper-responsiveness related symptoms (trouble breathing, wheezing, and/or attacks of shortness of breath, nocturnal cough, and/or chest tightness in the previous 12 months, and current allergic symptoms), and they found an association with general cleaning (OR 1.63, 95% CI 1.21–2.19) and aerosolized medication administration (OR 1.40, 95% CI 1.06–1.84).

The type and design of respiratory care equipment we use are crucial. Somogyi et al showed that the type of mask chosen can influence the exposure of infectious agents of RTs.[13] They showed that a non-vented mask with expiratory filter can minimize aerosol droplet exposure. Hui et al showed that the dispersion of particles during nebu-

lization increases with the severity of lung disease, and ranges from 0.45 m to 0.8 m.[14] More recently, Simonds et al evaluated droplet dispersion that occurs during noninvasive ventilation, oxygen therapy, nebulizer therapy, and chest physiotherapy.[15] They found that noninvasive ventilation using a vented mask produced droplets in the large size range in patients and coryzal subjects, but not in normal controls. They also reported that chest physiotherapy produced droplets predominantly larger than 10 μm, and that oxygen therapy did not increase droplet count in any size range. They found that nebulized saline delivered droplets in the small and medium size range. These document the potential infectious risks that RTs have while providing these services. These risks are even larger for RTs caring for infants and children, because close proximity to the patient cannot be avoided. During the influenza outbreak the Centers for Disease Control recommended the use of N95 mask to individuals participating in droplet/aerosol generating procedures.[16]

We need to review our current practices in light of the risks of infectious and aerosol exposure so that we can provide a safer environment for RTs. Several questions come to mind. Do we need to use expiratory filters with all nebulizer treatments? Do we need to consider increasing the use of breath-actuated nebulizers? Can chambers be added to nebulizers to decrease environmental exposure? Should we try to avoid disconnecting patients from ventilators to administer aerosol treatments? More research is needed to answer these questions. I will borrow some thoughts from Professor Rubin's 2011 Kittredge Memorial Lecture, and say that we should approach this problem with an open mind so that we can dispel myths, resolve the misunderstandings, and remove the dogma from respiratory care practices.[17]

Manufacturers should be mindful of environmental exposures generated by their products, and include in their designs systems that mitigate this problem. Regulators should keep these problems in mind as well, so that safer devices are approved by the regulatory agencies. RTs should also practice in a safe manner, minimizing exposures and seeking medical attention if they suffer from recurrent respiratory symptoms.

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REFERENCES

1. Kern DG, Frumkin H. Asthma in respiratory therapists. Ann Intern Med 1989;110(10):767-773.
2. Christiani DC, Kern DG. Asthma risk and occupation as a respiratory therapist. Am Rev Respir Dis 1993;148(3):671-674.
3. Dimich-Ward H, Wymer ML, Chan-Yeung M. Respiratory health survey of respiratory therapists. Chest 2004;126(4):1048-1053.
4. Delclos GL, Gimeno D, Arif AA, Burau KD, Carson A, Lusk C, et al. Occupational risk factors and asthma among health care professionals. Am J Respir Crit Care Med 2007;175(7):667-675.
5. Yu IT, Li Y, Wong TW, Tam W, Chan AT, Lee JH, et al. Evidence of airborne transmission of the severe acute respiratory syndrome virus. N Engl J Med 2004;350(17):1731-1739.
6. Novel Swine-Origin Influenza A (H1N1) Virus Investigation Team; Dawood FS, Jain S, Finelli L, Shaw MW, Lindstrom S, Garten RJ, et al. Emergence of a novel swine-origin influenza A (H1N1) virus in humans. N Engl J Med 2009;360(25):2605-2615. Erratum in: N Engl J Med 2009;361(1):102.
7. Gralton J, Tovey E, McLaws ML, Rawlinson WD. The role of particle size in aerosolised pathogen transmission: a review. J Infect 2011;62(1):1-13.
8. Kacmarek RM, Kratohvil J. Evaluation of a double-enclosure double-vacuum unit scavenging system for ribavirin administration. Respir Care 1992;37(1):37-45.
9. Demers RR, Parker J, Frankel LR, Smith DW. Administration of ribavirin to neonatal and pediatric patients during mechanical ventilation. Respir Care 1986;31(12):1188-1196.
10. Fallat RJ, Kandal K. Aerosol exhaust: escape of aerosolized medication into the patient and caregiver's environment. Respir Care 1991;36(9):1008-1016.
11. McKeown SI, Serrequi N. Modification of a high frequency oscillator circuit with a heated expiratory filter to prevent infectious pathogen transmission: a bench study. Respir Care 2012;57(4):531-536.
12. Fink JB. Device and equipment evaluations. Respir Care 2004;49(10):1157-1164.
13. Somogyi R, Vesely AE, Azami T, Preiss D, Fisher J, Correia J, Fowler RA. Disperal of respiratory droplets with open vs closed oxygen delivery masks: implications for the transmission of severe acute respiratory distress syndrome. Chest 2004;125(3):1155-1157.
14. Hui DS, Chow BK, Chu LCY, Ng SS, Hall SD, Gin T, and Chan MTV. Exhaled air and aerosolized droplet dispersion during application of a jet nebulizer. Chest 2009;135(3):648-654.
15. Simonds AK, Hanak A, Chatwin M, Morrell MJ, Hall A, Parker KH, et al. Evaluation of droplet dispersion during non-invasive ventilation, oxygen therapy, nebuliser treatment and chest physiotherapy in clinical practice: implications for management of pandemic influenza and other airborne infections. Health Technol Assess 2010;14(46):131-172.
16. Centers for Disease Control and Prevention. Prevention strategies for seasonal influenza in healthcare settings: guidelines and recommendations http://www.cdc.gov/flu/professionals/infectioncontrol/healthcaresettings.htm. *Accessed January 31, 2012.*
17. Rubin BK, Haynes JM. Myths, misunderstandings, and dogma in respiratory care. Respir Care 2012 (in press).