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## LETTER TO EDITOR

### High justification for universal stringent precautions in lung function testing

*Sir,*

I read with great interest the recent review article by Kendrick et al.[1] regarding infection control in lung function (LF) equipment. I share the authors' view that "There is clear evidence that respiratory equipment becomes contaminated with microorganisms of probable respiratory tract origin during use" and their view that "there is a need for clear procedures to be in place to reduce possible risks to a realistic minimum." I agree with some of their recommendations, such as the referring clinicians should complete an LF testing request form for each patient with questions relating to the patient's infection and immunity status; the patients with known infections are tested at the end of the day or in their own rooms. However, I do not agree with some of their other views and recommendations:

1. I disagree with the authors' view that for the majority of patients, there will be no significant risk of cross-infection from having LF tests.[1] Chronically ill patients and elderly persons (65-years old or over) are susceptible to respiratory infections[2] and should be considered as high-risk subjects to cross-infection in LF tests. These individuals plus immunocompromised patients and infected patients would probably make up more than 50% of the population for LF testing in most clinical LF laboratories/units. (In the past ten years, more than 70% subjects tested in my unit were elderly.)
2. I disagree with the authors' view that stringent precautions are not justified for the majority of the patients undergoing LF tests based on the current evidence of minimal cross-infection associated with LF equipment.[1] In my view, to make infection control recommendations for LF tests, we should not rely only on the current evidence that may result from "publication bias, the impracticality of performing large scale monitoring studies, and probably the lack of enthusiasm for this type of study."[1] Currently, with respect to cross-infection associated with LF test, there are no contamination study data available on unheated pneumotachographs, turbine spirometers or hot-wire spirometers; there are very few bacterial studies on patients and no viral data at all on LF equipment and patients. Therefore, we should use theoretical rationales to make the recommendations. Theoretically, the risk of cross-infection via LF tests may be substantial. When performing LF tests, patients often create a large amount of visible and invisible droplets of saliva or mucus, which may contain many pathogens, by forced exhalation and coughing. If no barrier filters are applied, the droplets may deposit into the breathing circuits of LF equipment. In this case, if only mouthpieces are replaced and no other infection control measures are taken between patients, the deposited droplets may be aerosolized by the subsequent patients through high inspiratory flow rates during LF tests and inhaled into their lungs; more importantly, the droplets may be desiccated quickly and become easily inhalable droplet nuclei.[3] Therefore, contaminated LF equipment may become an important source of infective pathogens and pose a significant risk to the patients undergoing LF tests. Although only a few cases of cross-infection associated with LF testing have been reported, the true number of the case could be grossly underestimated due to ignorance, concealment, technical difficulty or the lack of infection control guidelines and surveillance. Recently, a registered nurse informed me that in 1996, her immunocompromised daughter suffered from chest infection of Pseudomonas after performing some LF tests (without a single-use filter) on a device, which were shared by some cystic fibrosis patients, in an LF laboratory. While her respiratory specialist considered that the infection was possibly due to the contaminated LF device, some people related it to "bad luck". This case was not reported until I wrote

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to the Department of Communicable Disease Surveillance and Response, World Health Organization (WHO) in August 2003. I think it is possible that many cases like this have gone unreported. Pre-LF test screening by the request form, although helpful, cannot substitute other effective infection control measures, because it is very difficult to identify all the patients with either infectious diseases or immunocompromised illnesses by clinical signs. A recent study shows as many as 40% clinically stable chronic obstructive pulmonary disease (COPD) patients have positive sputum cultures to potentially pathogenic microorganisms.[4] Also, it is impractical to test each patient for all infectious diseases before LF testing. Therefore, universal stringent precautions for everyone in LF tests are really needed and highly justified. In 1991, the head author of the recent article clearly recommended, based on the theory of rationales, that "Breathing circuits: All testing equipment that comes into direct or close contact with mucous membranes, i.e. mouthpieces, pneumotachographs, tubing and rebreathing valves, should be disinfected before use on other patients."[5] However, the recent article states: "Breathing circuits: in practice, disinfection at the end of each day, rather than between each patient should be sufficient."[1] I would like to question the head author's reasons why the previous recommendation with universal high-level measure for breathing circuits has been significantly downgraded, despite the fact that the incidence of infectious diseases has been increasing in recent years.

3. Respiratory viral infections, which may be easily transmitted by infected aerosols, account for significant mortality and morbidity. Much smaller doses of viruses than that of bacteria may cause respiratory infections.[6] The authors of the recent article only list one respiratory virus (rhinovirus) and do not mention other important respiratory viruses, such as influenza virus, respiratory syncytial virus, and severe acute respiratory syndrome (SARS)-associated coronavirus that suddenly and lethally attacked people around the world without warning in 2003 and remains a severe threat. In addition, the authors consider the cross-infection of a common cold as only causing inconvenience to patients. In fact, to healthy people it may cause substantial discomfort, absenteeism and economic losses;[3] to patients with asthma or COPD, it may cause severe exacerbations and complications. I believe that, any preventable cross-infection acquired from LF testing is not acceptable.
4. Some recommendations in the recent article are substandard. For exercise testing breathing circuits (Hans Rudolf valves), it states: "Dismantling, washing in hand-hot soapy water, rinsing and drying should be sufficient to ensure adequate cleaning and disinfection."[1] I would like to question the authors the scientific basis and the efficiency of this disinfection method. A study, which used an insensitive sampling method described by the head and the third authors,[7] found that 13% of the samples from a heated pneumotachograph were contaminated. But in the recent article, the authors only recommend "minimal cleaning".[1]
5. One recommendation in the recent article is impractical and inefficient. In Table 3, the recommendation of disinfection for breathing circuits shows: "Patient valves—clean between patients with alcohol wipes."[1] (It implies that the authors are concerned over the contamination of the proximal rebreathing parts of LF equipment between patients.) But the disadvantages of alcohol wipe, as pointed out by the authors in Table 1,[1] are that valves and flow sensors cannot be decontaminated thoroughly by this method (parts of them easily missed).
6. The authors recommend high-level precautions for peak flow meter: "either a one-way valve mouthpiece or a new barrier filter should be used for each patient."[1] On the other hand, they consider that the routine use of filters in LF tests is difficult to justify due to cost constraints,[1] which is not consistent with the former recommendation. Good quality barrier filters with high filtration efficiency, low air resistance and small dead space have been available for at least 5 years. The main advantage of applying single-use high-efficient filters in LF testing is that they can protect: (a) breathing circuits, especially flow sensors from contamination with droplets of saliva and mucus,[8] which may contain microorganisms and induce test errors; (b) patients from inhaling pathogens from the breathing circuits; (c) the air of the surrounding area from contaminated aerosols, hence the technical staff and the patients. I believe, the universal use of single-use filters is actually very reasonable and cost-effective, and can reduce the cross-infection risks during LF tests into a realistic minimum. The barrier filters can also act as mouthpieces and may significantly reduce the costs for disinfection, and for replacement of breathing circuits worn by disinfectants. Indeed, the cost of a high-efficient filter for LF testing is very little in many developed countries. Now in Australia, it costs only AU$

2.00–2.50 each, being about twenty times lower than the cost of a flu vaccination for a person. With the cooperation of the world experts to verify and unify barrier filters, their costs can be dramatically reduced by mass production, and can be made affordable to the developing countries. Moreover, with the application of media-changeable filters (every filter case being disinfected after each patient use), the costs can be further cut by half.

The World Health Report 2003 by WHO[9] points out that: ''New diseases have been emerging at the unprecedented rate of one a year for the last two decades, and this trend is certain to continue.'' In the first half of 2003, SARS posed a particularly serious threat to people's health. Its initial symptoms were non-specific and common, and maximum incubation period, estimated at 10 days, allowed international spread by air travel. SARS also caused widespread social disruption and huge economic losses (estimated US$ 30 billion loss in the Far East alone).[10] One of the lessons learnt from SARS outbreaks, pointed out in the WHO 2003 annual report, is that ''weaknesses in health systems can permit emerging infections to amplify and spread, and can compromise patient care. The strengthening of health systems thus deserves high priority.''[9] I believe that, we should rigorously prevent the spread of the exiting infectious diseases and should be well prepared against the recurrence of SARS and the emergence of new highly infectious diseases, including the next influenza pandemic. Therefore, we should implement upgraded and strengthened precautions for all the patients undergoing LF tests. Until now, applying single-use high-efficient filters followed by regularly disinfecting respiratory circuits is the most practical and effective approach to prevent cross-infection in LF tests.

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