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Evaluating the Sterility of Disposable Wall Oxygen Humidifiers, During and Between Use on Patients

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INTRODUCTION

Oxygen wall humidifiers are used regularly in the hospital. Although the humidifiers in mechanical ventilators have been extensively investigated,¹ oxygen wall humidifiers are often neglected in the literature. Both reusable and disposable humidifiers are available, and according to the recommendation from the Centers for Disease Control (CDC), both types of humidifiers are acceptable.² For reusable humidifiers however, it is crucial that they be washed daily as recommended and that water left in the reservoir be discarded before refilling.²

In the CDC guideline for the prevention of nosocomial pneumonia, it is stated that disposable humidifiers for wall oxygen outlets "may be safe for long periods."² However, studies that actually assess the efficacy of these humidifiers on patients are rarely reported, and, to the best of our knowledge, only one such study has been published.³

Another issue that is still ambiguous is the handling of partially used disposable humidifiers after oxygen therapy is completed. As pointed out by the CDC, it is not known if they should be routinely changed or whether they could be kept on the wall outlet until treatment is needed by another patient.² In an *in vitro* experiment, the sterility of these humidifiers could be maintained for up to 77 days after the seal on the humidifier's nozzle was broken,⁴ but an *in-use* evaluation in the wards has not been reported.

We describe an *in-use* evaluation of the "Aqua-pak" (Kendall, Boston, Massachusetts) disposable humidifiers, and assess whether it is safe to

leave these humidifiers partially empty on the wall oxygen outlet until they are required by another patient.

METHODS

The subjects of this study were patients admitted to the medical or surgical wards of Queen Mary Hospital, Hong Kong, in which oxygen therapy without mechanical ventilation was ordered by the attending physician.

Humidifiers containing 325 ml of sterile water were used, and these were attached to the wall outlet in the usual manner for oxygen therapy. Upon completion of therapy, humidifiers that were partially used would be left on the same wall outlet until treatment was required for another patient.

All humidifiers on wall outlets were inspected daily by the infection control nurse. For those that were in continuous use, the humidifiers would be changed when the water level was 0.5 cm from the bottom, and the remaining water would be submitted for culture. For unused humidifiers left on the wall outlet, water samples would be collected for culture weekly and before onset of the next treatment. The humidifier's nozzle was threaded with a sterile catheter (an infant feeding tube, French size 5), and 2 ml of water was obtained aseptically.

For bacteriological study, 0.1 ml of each sample was cultured on blood and MacConkey agar. Full bacteriological quantitation was performed for samples with a positive growth. One ml of the sample also was inoculated in 9 ml of brain heart infusion broth and incubated at 37°C. The broth was then subcultured on blood and MacConkey agar after three days or earlier, if turbidity was noted. All cultured plates with negative bacterial growth were incubated at 37°C for 48 hours.

RESULTS

A total of 46 humidifiers were evaluated, and the duration of continuous usage for oxygen therapy on patients is shown in Table 1. The range was one to six days, and the mean was three days.

Twenty-four humidifiers were left unused on the wall outlet for a period of time, and the duration of unused days is shown in Table 2. The range was

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Table 1
Duration of Continuous Oxygen Therapy for 46 Disposable Wall Humidifiers

Duration of Continuous Use (Days)	No. Humidifiers
>1-2	12
>2-3	13
>3-4	6
>4-5	12
>5-6	3
Total	46

one to 25 days, and the mean was seven days. Confidence limit (95%) was also calculated, and this was four to ten days (standard deviation [SD]=7.4).

The bacteriological cultures of all water samples were negative.

The patients connected to these humidifiers were varied; 30 humidifiers were used on patients receiving antibiotics and 15 were used on patients who had a recognized pathogen (*Staphylococcus aureus* or a gram-negative bacteria) isolated in the sputum.

DISCUSSION

Disposable wall oxygen humidifiers are "pre-filled" with sterile water, which is expected to remain sterile during the course of oxygen therapy. Theoretically, this seems acceptable because air flow in these humidifiers is unidirectional toward the patient, and there is no evidence that backflow of condensate, demonstrated in humidifiers for mechanical ventilators,⁵ is significant. Experimental data indicate that this is also true in practice. Stoler reported that sterility was maintained when 92 disposable humidifiers were used continuously for oxygen therapy for one to nine days.³ Similarly, sterility was maintained in the 46 humidifiers evaluated in this study.

There is also evidence to indicate that partially empty humidifiers could remain sterile on the wall outlet before use on another patient. Meehan showed, in an experiment with 14 humidifiers, that

Table 2
Duration in Which Partially Empty Humidifiers Were Left Unused on the Wall Outlet

Duration (Days)	No. Humidifiers
>1-2	5
>2-3	3
>3-4	2
>4-5	4
>5-6	2
>6-10	3*
>10-15	1†
>15	4‡
Total	24

* Two were eight days and one was nine days.

† 14 days

‡ 19, 20, 24 and 25 days

sterility could be maintained for up to 77 days.⁴ However, it was an in vitro study, and the humidifiers were never connected to patients for oxygen therapy. The present study was an in-use assessment, and when humidifiers were left on the wall outlet, sterility was maintained for up to 25 days. However, the confidence limit was four to ten days, and until further experimental data are available, the ten-day upper limit probably should not be exceeded.

In conclusion, the sterility of disposable wall humidifiers could be maintained when used continuously for oxygen therapy. For those that are partially empty, it is acceptable to leave them on the wall outlet for up to ten days, until treatment is required by another patient.

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