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Is disinfection of mechanical ventilation tubing needed at home?

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Abstract

Introduction: Home mechanical ventilation is used to treat chronic alveolar hypoventilation. Maintenance protocols for home ventilation circuits (HVC) remain empirical and unproven. We have investigated (1) the cleanliness and sterility of the HVC used by home ventilated patients and (2) the efficiency of tubing cleaning and decontamination protocols recommended to them and used for 12 months or more.

Method: HVC cleanliness was assessed in 39 severe restrictive ventilated patients (16 (T) tracheostomy vs. 23 (N) noninvasive) and in 7 new valves as control. In the first experiment (Exp1), a visual and bacteriologic inspection of the expiratory valve (Eva) was conducted during a consultation in our centre. Eva visual cleanliness was assessed on a 10-point scale and Eva bacteriologic contamination analysis was performed on a dry smear. In the second experiment (Exp2), these analyses were repeated after a cleaning sequence chosen at random, either chemical (ammonium-chlorhexidine complex) (A) or mechanical by dishwasher (B).

Results: In Exp1, 69% of Eva were dirty. Dirtiness was worse in (T) than in (N) (5.3 vs. 2; $p<0.001$). There was a significant positive correlation between visual cleanliness and bacteriologic contamination ($r=0.56$; $p<0.001$). Eva in group (T) were more contaminated than in group (N) ($p<0.001$). Eva contamination rates reached 22% in group (N) but without the presence of any potentially pathogenic organisms (PPO) and 81% in group (T) where 19% were PPO. In Exp2, EVA visual cleanliness was better after dishwasher cleaning (B) compared to chemical (A) (0.16 vs. 1.05; $p<0.001$) with similar bacteriological decontamination.

Conclusion: HVC from noninvasive ventilated patients are dirty but not contaminated by PPO. We recommend washing them in a dishwasher or with detergent and hot water without specific disinfection. PPO contaminated 1/5 of invasive HVC, for which we recommend dishwasher cleaning. Decontamination is only indicated when tubing is visually very dirty or/and when tracheostomized patients are particularly sensitive to respiratory tract infections. The expiratory valve must be carefully washed specifically, with care that its balloon is not placed under water.

Keywords: Home mechanical ventilation; Tubing; Restrictive; Dishwasher; Disinfection; Cleanliness

Introduction

Home mechanical ventilation is an effective treatment for alveolar hypoventilation in patients with neuromuscular disorders or high-level cord injury (Anonymous,

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1999; Baydur et al., 1990; Philips et al., 1999). We choose to set up patients as an inpatient initiation during the ventilation learning period (Leger et al., 1989), with educational sessions on safe ventilation and ventilator hygiene given to the patient and their carers (Bahng et al., 1998). Surprisingly, few data regarding the maintenance of home ventilation circuits (HVC) are available, instructions mostly being taken from the guidelines from other areas such as intensive care (Girou et al., 2000; Goetz et al., 1990; Harrison, 1993; Laguanie et al., 1983; Perrin et al., 2004; Quirke and French, 1996; Stamm, 1998), spirometric tests (Burgos et al., 1996; Dautzenberg, 2001; Kendrick et al., 2003), nebulization techniques (Clancy, 2003; Gautier, 1999; Melani et al., 2001) or respiratory monitoring (Wilkins, 1993). These instructions are generally based upon tradition rather than scientific evidence (Clancy, 2003; Harrison, 1993) and vary depending on the countries and centres (Kendrick et al., 2003). The specific rules of ventilator hygiene are generally available in the manufacturers' instructions and from professionals-patients associations, for example, ANTADIR in France (www.antadir.com), but they are not specifically adapted for home ventilator use (Gautier, 1999; Harrison, 1993). Instructions are often too elaborate, including disinfection without specifying how this can be done simply. To our knowledge, only one study has assessed the basic visual cleanliness of HVC at home with classification as either acceptable or unacceptable, and comparing this state to HVC contamination (Rodriguez Gonzalez-Moro et al., 2004). Tubing and masks were "unacceptably" dirty at a high rate of 68% and the majority of HVC were contaminated. The link between contamination and respiratory tract infection was discussed, but the efficiency of cleaning and disinfection methods was not studied. Some basic hygiene questions remain unanswered: How clean are the circuits? Are they colonized by microorganisms? Are these potentially pathogenic organisms (PPO)? Is our cleaning guideline adequate? Does it need improvement or adaptation? Is tubing disinfection needed? Is this necessary for each patient?

The objective of this study was to determine (1) the HVC cleanliness and sterility level in home ventilated patients and (2) the efficiency of the maintenance protocol for HVC cleaning recommended to them.

Materials and methods

Population

Expiratory valves (Eva) of 39 patients ventilated at home for more than 12 months were analysed. The mean period they were ventilated was 7.7 (SD ± 4.5) years. Sixteen were treated by tracheostomy (group T) and 23 noninvasively with a nasal mask (group N). In group (N), 13 were ventilated via a silicone custom made mask and 10 via a commercial mask (6 via Contour® and 4 via Profile® masks; Respironics®, Murrysville, USA). Twenty-four were continuously ventilated, 16 by tracheostomy and 8 by mouthpiece during the day and by nasal mask during the night. Eleven lived in institution and 28 lived at home. All of them had functional tetraplegy with chronic alveolar hypoventilation (24 Duchenne muscular dystrophies, 4 congenital myopathies, 2 polyneuropathies, 4 spinal muscular atrophies, 4 tetraplegics, and 1 limb girdle dystrophy). All respirators were volumetric. In tracheostomized patients, the circuits were connected to a humidifier and a water trap. In addition, 7 new valves were examined as control.

Methods

Before starting long-term ventilation, patients had received cleaning instructions, according to the following protocol: to clean macroscopic spots with detergent and hot water, followed by a 15 min ammonium-chlorhexidine complex bath (HAC® Hospital Antiseptic Concentrate; Healthcare Belgium, Groot-Bijgaarden, Belgium) diluted to 5%. We recommended circuit, tubing and interfaces decontamination by HAC® twice a month and cannulae of tracheostomy cleaning with hydrogen peroxides (oxygen water). This protocol was taught to the patients and written instructions were also given.

Two analyses, a visual one and a bacteriologic one, were conducted in a first experiment (Exp1) and in a second experiment (Exp2) (Fig. 1). In Exp1, visual analysis included both Eva and complete circuit (Eva and tubing) inspection. In Exp2, visual analysis included only Eva inspection. Bacteriologic analysis was conducted in Exp1 and Exp2 solely on the valve. These analyses were made by the same investigator during patient consultations in our centre for mechanical ventilation or during hospitalization excluding respiratory infection context. The patients were not informed about the study in order to avoid any extra cleaning before the visit. The time of ventilation with tubing and valve reached from 6 to 12 months in all the patients. Reassessment in Exp2 was made the day after Exp1.

In Exp1, the analysis was made when the patient arrived, aiming to give evidence of the efficacy of the routine maintenance protocol that patients learned previously and that they were expected to achieve at home. Our low-level decontamination and cleaning protocol clearly contrasts with the high-level disinfection protocol proposed to cystic fibrosis patients (CF). This is justified by the restrictive properties of the paralytic patients well-known to have no particular