Bacterial contamination of multiple-use atomizers commonly used in Japan

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Abstract Before performing transnasal fiberoptic to observe the nasal cavity, pharynx and larynx in outpatient clinics, nasal anesthetics and vasoconstrictive agents are routinely sprayed into the nares in order to improve patients' comfort. Bacterial contamination of the nozzles of Venturi principle atomizer barrels and their solutions after being used for multiple patients over a long-term period without cleaning is controversial. We evaluated the potential risk of atomizer-associated cross-infection by using atomizers commonly available in Japan that use compressed air to atomize medication. Eighteen of the 23 samples (78.3%) from the external nozzle tips of the atomizers resulted in positive bacterial cultures. These detected bacteria are suggested to be colonized in the nares and to cause bacterial contamination of the atomizer. Of the 25 samples obtained from the spray of the drug solutions, 11 samples showed positive bacterial culture, whereas 16 control samples produced no growth of bacteria. The present study demonstrated that the atomizer widely used in the outpatient ENT clinics in Japan has a potential risk of causing cross-infection of patients.

Keywords Bacterial culture · Atomizer · Nozzle · Fiberoptic · Local anesthesia

Introduction

Before performing transnasal fiberoptic to observe the nasal cavity, pharynx and larynx in outpatient clinics, nasal anesthetics and vasoconstrictive agents are routinely sprayed into the nares in order to improve patients' comfort. Although it has been believed that topical nasal anesthesia is no more effective than placebo, recent evidence has shown that use of topical nasal anesthesia can improve patients' comfort [1, 2]. Therefore, intranasal anesthetic treatment has become a standard procedure given before performing transnasal fiberoptic.

Bacterial contamination of the nozzles of Venturi principle atomizer barrels and their solutions after being used for multiple patients over a long-term period without cleaning is controversial. Several studies have suggested that Venturi principle atomizer devices [3–6], as well as anesthetic spray applicators [7, 8], might be sources of patient cross-contamination. Some researchers have advocated single-use disposable nasal sprayers [3], or sterilization of nozzles after each use, or the use of disposable nozzle attachments [6]. It has also been reported that external bacterial contamination of the atomizer nozzle tip resulted in internal bacterial contamination of Venturi devices in as little as one use but not of positive displacement devices [9–12]. Discrepancies in the results among previous studies are judged to have been caused by the sample protocols used to evaluate cross-contamination of the atomizer. Spraggs et al. [4] permitted the tip of the nozzle to come in contact with the superior rim of the nasal vestibule. On the other hand, Visosky et al. [10] and Scianna et al. [11] used a method designed to prevent contact between the atomizer tip and nasal membranes. In the practical use of the atomizer during spraying, a variety

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of techniques and applications in different situations and patients can be expected. Therefore, in the present study, atomizers were freely used by multiple ENT doctors for 2 weeks.

In the present study, we designed 3 series of experiments to evaluate the potential risk of atomizer-associated cross-infection by using atomizers commonly available in Japan that use compressed air to atomize medication. These experiments included: (i) bacterial culture of the external tip of the nozzle, (ii) bacterial culture of the external tip after disinfection of the tip by ethanol cotton and (iii) bacterial culture of the solutions.

Materials and methods

Preparation of atomizer and drug solutions

Six separate examination rooms in the outpatient ENT clinic were equipped with the Venturi system atomizer (Nagashima Medical Instrument, Tokyo, Japan) connecting to two bottles; one containing 4% lidocaine (xylocain RR) and the other containing 0.02% epinephrine. The drug solution contained in the atomizer was aerosolized via air forced in by the pump (Fig. 1).

Although a nasal speculum is generally used to spread the patient's nares widely before insertion of the atomizer tip, care about contact between the nasal mucosa and the atomizer tip is dependent upon the aim of spraying, patient's situation, doctor's decision etc. Each atomizer is used on multiple patients and by multiple ENT doctors. Disposable atomizer tips or reusable nozzle attachment are not used.

Atomizers are sterilized every two weeks. Sterilization is accomplished by disassembling the atomizer, discarding any remaining drug solution and sterilizing the atomizer's metal nozzle, glass container and inner metal cannula in

ethylene oxide gas. The solution bottle is filled with the new sterilized drug solution when the atomizer is sterilized.

Microbiologic studies of atomizer equipment and solutions

Three methods were used for bacterial culture. In one, the external nozzle tip was swabbed by saline-soaked cotton, which was then applied to each of the following 4 bacterial culture media: 5% sheep blood agar, chocolate agar, Columbia anaerobic blood agar, and liquid thioglycolate broth. In the second, the same culture protocol was performed after the external tip was wiped by 80% of ethanol. In the third, samples were obtained by spraying a <1-second continuous spray of 2 types of drug solutions onto the agar plate. Control samples were obtained from the atomizers after sterilization but before use on patients.

Results

Each atomizer was used for 40 to 50 patients on an average per day for 12 days (2 weeks except Sundays). Of the 23 samples obtained from the external nozzle tip of the atomizer in 6 examination rooms, 18 samples (78.3%) resulted in positive bacterial cultures. The bacterial culture resulted in 6 samples of *Corynebacterium spp.*, 5 samples of coagulase-negative *Staphylococcus* (CNS), 4 samples of *Propionibacterium spp.*, 1 sample of methicillin-resistant *Streptococcus aureus* (MRSA), 1 sample of *Streptococcus aureus*, and 1 sample of yeast-like cell (Fig. 2). These detected bacteria are consistent with those colonized in the nares. It is suggested that bacterial contamination of the atomizer is derived from the nares of patients although the origin of bacterial contamination was not confirmed. After sterilization of the external tip with ethanol, no bacterial growth in 12 samples was observed in the tip. Of 25 samples obtained by spray of the drug solutions, 11 samples

Fig. 1 Photograph of Venturi principle atomizer used in the present study

Fig. 2 Results of bacterial culture from the nozzle tip of the atomizer. Parentheses indicate the number of colonies of each bacteria.

produced a total of 19 colonies: 12 *Corynebacterium spp.*, 6 CNS, and 1 - *Streptococcus* were identified (Fig. 3). On the other hand, 16 control samples produced no growth of bacteria.

Discussion

The present study demonstrated that the atomizer widely used in the outpatient ENT clinics in Japan has a potential risk of causing cross-infection of patients. Before bacterial examination of the atomizers, we confirmed whether nasal spray for local anesthesia is necessary in the use of transnasal fiberoptic. Eighty-two percent of 17 volunteers complained of discomfort during transnasal fiberoptic without local anesthesia. Local anesthesia resulted in bad taste or smell in 59% of the subjects, whereas no one without anesthesia felt bad taste or smell. All of the participants examined preferred to have local anesthesia before nasal fiberoptic. These results support the opinion that local anesthesia of the nasal cavity is required before transnasal fiberoptic, which is compatible to the findings of previous reports [1, 2].

Sampling protocols were restrictively designed in the previous studies, which would have resulted in an extremely low rate of bacterial growth from the drug solutions of the atomizer [10, 11]. The sampling protocol adopted in the present study is thought to be more realistic as compared with those used in previous studies since in clinical practice the tip of the atomizer nozzle has the possibility of coming in contact with the nasal mucosa or vestibule and hair. External tips were found to be contaminated with bacteria often identified in the nares, which may induce the contamination of the internal tube directing passage of the drug

solutions. Another explanation for the contamination of the drug solutions may relate to the mechanism of action of the Venturi system atomizer's "vacuum effect", which implies a momentary vacuum at the nozzle tip on cessation of positive pressure, resulting in a transient suction of materials into the device [3]. Although most of the bacteria detected from the external tips are normal flora, rather than respiratory pathogens, the fact that colonies of MRSA and MSSA were detected provides evidence for the potential risk of patient cross-contamination.

To prevent the cross-infection potential of multi-use atomizers, several methods have been proposed. First, cleaning the tip with an alcohol swab was proven to eliminate bacteria from the external nozzle tip in the present study, which is consistent with the previous report by Dubin et al. [6]. However, the possibility of contamination of the inner tube of the nozzle or the drug solution cannot be neglected. Furthermore, the alcohol used in detergents cannot inactivate some viruses [13]. Second, use of a simple exchangeable nozzle which can be re-sterilized and then re-used, as well as a positive displacement atomizer has been recommended by Williams et al. [7] and Wolfe et al. [9]. However, based on practical and economic reasons and the present marketing situation of atomizers in Japan, it may be difficult to promptly produce new types of instruments such as an easily exchangeable nozzle and a completely positive displacement atomizer. Lastly, a single-use disposable nasal spray, as described by Coakley et al. [3], is thought to be the most suitable method, especially based on economical reasons. Thus, our clinic has started using a single-use spray bottle for local anesthesia of the nasal fossa, which is sterilized after each procedure. The same trial has been currently reported that a reusable spray device requires additional precautions to prevent interpatient cross-contamination [14]. Further development of devices for local anesthesia in the nasal fossa are needed to minimize the cross-contamination of the patients.

The problem of cross-contamination can be simply overcome by having multiple nozzle tips and using each nozzle tip only once. These nozzle tips can be re-sterilized and then reused again. This could be a more cost-effective and safe option. The other alternative that is used in many centers of United states is having a spray bottle with multiple detachable spray tips. Each tip is used only once and subsequently sterilized and re-used.

Fig. 3 Results of bacterial culture from the drug spray of the atomizer. Parentheses indicate the number of colonies of each bacteria.

References

1. Noorily AD, Otto RA, Noorily SH (1995) Intranasal anesthetic effects of lidocaine and tetracaine compound. *Otolaryngol Head Neck Surg* 113:370–374
2. Johnson PE, Belafsky PC, Postma GN (2003) Topical nasal anesthesia for transnasal fiberoptic laryngoscopy: A prospective, double-blind, cross-over study. *Otolaryngol Head Neck Surg* 128:452–454

3. Coakley JF, Arthurs GJ, Wilsher TK (1993) The need for and development of a single use disposable nasal spray. *J Laryngol Otol* 107:20–23
4. Spraggs PDR, Hanekom WvH, Mochlouis G, Joseph T, Kelsey MC (1994) The assessment of the risk of cross-infection with a multi-use nasal atomizer. *J Hosp Infect* 28: 315–321
5. Southwick KL, Hoffmann K, Ferree K, Matthews J, Salfinger M (2001) Cluster of tuberculosis cases in North Carolina: possible association with atomizer reuse. *Am J Infect Control* 29:1–6
6. Dubin MG, White DR, Melroy CT, Gergan MT, Rutala WA, Senior BA (2004) Multi-use Venturi nasal atomizer contamination in a clinical rhinologic practice. *Am J Rhinol* 18:151–156
7. Williams OA, Wilcox MH, Nicol CD, Spencer RC, Reilly CS (1993) Lignocaine spray applicators are a potential source of cross-infection in the anaesthetic room. *Anaesthesia* 48:61–62
8. Denlinger JK, Ellison N, Ominsky AJ (1974) Effects of intratracheal lidocaine on circulatory responses to tracheal intubation. *Anesthesiology* 41:409–412
9. Wolfe TR, Hillman TA, Bossart PJ (2002) The comparative risks of bacterial contamination between a Venturi atomizer and a positive displacement atomizer. *Am J Rhinol* 16: 181–186
10. Visosky AMB, Murr AH, Ng V, Dentoni T, Weir L, Haller BL (2003) Multiple-use atomizers in outpatient otolaryngology clinics are not necessarily an infectious risk. *Otolaryngol Head Neck Surg* 128:447–451
11. Scianna JM, Chow JM, Hotaling A (2005) Analysis of possible cross-contamination with the Venturi system atomizer. *Am J Rhinol* 19:503–507
12. Rizzi M, Batra PS, Hall G, Citardi MJ, Lanza DC (2005) An assessment for the presence of bacterial contamination of Venturi principle atomizers in a clinical setting. *Am J Rhinol* 19:21–23
13. Montefiori DC, Robinson WE, Modlisszewski A, Mitchell WM (1990) Effective inactivation of human immunodeficiency virus with chlorhexidine antiseptics containing detergents and alcohol. *J Hosp Infect* 15:279–282
14. Aydin E, Hizal E, Akkuzu B, Azap O (2007) Risk of contamination of nasal sprays in otolaryngologic practice. *BMC Ear Nose Throat Disord* 7:2