Gargling with povidone-iodine reduces the transport of bacteria during oral intubation

[Le gargarisme avec un mélange de povidone-iode réduit le transport bactérien pendant l'intubation orale]

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Purpose: Nosocomial pneumonia remains a common complication in patients undergoing endotracheal intubation. This study examined the transport of bacteria into the trachea during endotracheal intubation, and evaluated the effects of gargling with povidone-iodine on bacterial contamination of the tip of the intubation tube.

Methods: In the gargling group, patients gargled with 25 mL of povidone-iodine (2.5 mg·mL^{-1}). In the control group, patients gargled with 25 mL of tap water. Before tracheal intubation, microorganisms were obtained from the posterior wall of the patient's pharynx using sterile cotton swabs. After anesthesia, all patients were extubated and bacteria contaminating the tip of the tracheal tube were sampled and cultured.

Results: Before orotracheal intubation, all 19 patients who gargled with tap water (control group) had bacterial colonization on the posterior walls of the pharynx. This group included five patients who had methicillin-resistant *staphylococcus aureus* (MRSA) in their nasal cavity preoperatively and MRSA was also detected in the pharynx of four patients. Bacterial colonization was observed in all 19 patients who gargled with povidone-iodine (gargling group) and four patients carried MRSA in their nasal cavity, although no MRSA was detected in the pharynx. In the control group, all the patients had bacterial colonization at the tip of the tube after extubation. Additionally, MRSA was detected in two of the four patients. In the gargling group, povidone-iodine eradicated general bacteria and MRSA colonies in the pharynx before intubation and at the tip of the tube after extubation.

Conclusion: Gargling with povidone-iodine before oral intubation reduces the transport of bacteria into the trachea.

Objectif : *La pneumonie nosocomiale est une complication encore fréquente à la suite d'une intubation endotrachéale. Nous avons vérifié le transport des bactéries à l'intérieur de la trachée pendant l'intubation endotrachéale et évaluons les effets du gargarisme avec povidone iodé sur la contamination bactérienne de la pointe du tube d'intubation.*

Méthode : *Les patients du groupe de gargarisme ont utilisé 25 mL de povidone iodé (2,5 mg·mL^{-1}). Les patients témoins se sont gargarisés avec 25 mL d'eau du robinet. Avant l'intubation trachéale, les microorganismes ont été prélevés sur la paroi postérieure du pharynx au moyen de coton-tiges stériles. Après l'anesthésie, tous les patients ont été extubés et les bactéries de la pointe du tube trachéal ont été prélevées et mises en culture.*

Résultats : *Avant l'intubation orotrachéale, on a détecté des bactéries sur les parois postérieures du pharynx chez les 19 patients témoins. Ce groupe comprenait cinq patients avec staphylocoque aureus résistant à la méthicilline (SARM) dans la cavité nasale avant l'opération. Le SARM a aussi été détecté dans le pharynx de quatre patients. Il y avait une colonisation bactérienne chez les 19 patients qui ont utilisé le mélange povidone iodé. On a retrouvé le SARM dans la cavité nasale de quatre patients, mais non dans le pharynx. Tous les patients témoins présentaient une colonisation bactérienne à la pointe du tube après l'extubation. De plus, le SARM a été détecté chez deux des quatre patients. Par contre, la povidone iodé a éliminé les bactéries en général et les colonies de SARM dans le pharynx avant l'intubation et à la pointe du tube après l'extubation.*

Conclusion : *Le gargarisme avec povidone iodé avant l'intubation orale réduit le transport bactérien dans la trachée.*

NOSOCOMIAL pneumonia (NP) is a major factor related with hospital-acquired infection[1,2] and remains a common complication in patients undergoing endotracheal intubation and mechanical ventilation, and continues to have a significant impact on the mortality of these patients.[3-6] Endotracheal intubation impairs host-defence mechanisms including cough and mucociliary clearance.[7,8] Pooled secretions can cause bacterial overgrowth.[9,10] Absence of adequate salivary flow may facilitate development of mucositis and oropharyngeal colonization with gram-negative bacteria.[11] Kotani *et al.* (1995) found a strong correlation between the loss of pulmonary macrophages, which play an important role in host defense against infection, and the duration of surgery and anesthesia.[8] Although these findings suggest that endotracheal intubation during the perioperative period facilitates opportunistic pulmonary infection by the normal flora of the pharynx, there is little information on methods of preventing NP after endotracheal intubation during anesthesia.

Methicillin-resistant *staphylococcus aureus* (MRSA) is a nosocomial pathogen that has become of great concern in hospitals worldwide.[1-6] Up to 40% of the normal population carry *S. aureus* in the anterior nares, and this rate is often increased in hospitalized patients and their attendants.[1] Moreover, epidemiologic studies have shown that gram-negative bacteria account for most NP in intubated patients, but *S. aureus* may also play a role in polymicrobial infections.[9] The increasing incidence of MRSA has been associated with hospital outbreaks leading to considerable morbidity and the disruption of hospital services.

The efficacy of povidone-iodine for disinfection is known.[12-14] Shiraishi *et al.* (2002) reported that gargling with povidone-iodine had the highest disinfection rate and the highest reduction in the oral bacterial count.[12] Kawana *et al.* (2002) reported that gargling with povidone-iodine was useful for preventing nosocomial and opportunistic infections due to MRSA.[13] Nagatake *et al.* (2002) showed that povidone-iodine gargling reduced infections with *Pseudomonas aeruginosa*, *S. aureus* including MRSA, and *Haemophilus influenzae* by about 50%.[14] Therefore, gargling with povidone-iodine appears to be a simple, effective way to disinfect the upper respiratory tract.

In this study, we investigated whether preoperative gargling with povidone-iodine can reduce the transport of bacteria from the pharynx into the trachea with endotracheal intubation.

Methods

After obtaining approval of our Institutional Review Board and the patients' informed consent, 38 patients (ASA physical status I) scheduled for elective surgery under general anesthesia were randomized into two groups, one group gargled with povidone-iodine (gargling group) and one with tap water (control group). There were no restrictions to recruiting patients by type of surgery. Patients with a history of a reaction to iodine or upper respiratory tract disease were excluded from this study. Patients with a history of a gastroesophageal reflux or regurgitation were also excluded from this study. All patients were investigated to see whether they carried MRSA in the nasal cavity preoperatively.

None of the patients received sedative drugs preoperatively. In the gargling group, patients gargled with 25 mL of povidone-iodine (2.5 mg·mL^{-1}) for one minute, twice. In the control group, patients gargled with 25 mL of tap water for one minute, twice. After preoxygenation, general anesthesia was induced with 1.5 mg·kg^{-1} propofol and 0.1 mg fentanyl intravenously, and maintained with 1.5 to 2% sevoflurane in 5 L·min^{-1} oxygen. Before tracheal intubation, microorganisms were obtained from the posterior wall of the patient's pharynx using sterile cotton swabs. Vecuronium (1 mg·kg^{-1} *iv*) was used to facilitate intubation. Endotracheal tubes with inner diameters of 7.5 and 8.0 mm with a low-pressure cuff (Sheridan™; Kendall Healthcare Products Co., Inc., Mansfield, MA, USA) were inserted orally. The endotracheal tubes were lubricated with 1 mL 10% xylocaine to avoid sore throat. Wearing sterile gloves, a single skilled anesthesiologist blinded to group assignment performed all intubations with an autoclaved curved laryngoscope. Patients in whom more than two attempts at passage of the endotracheal tube were required were excluded from the study. The cuff was inflated to the point of obtaining a seal in the presence of positive airway pressure. After emergence from general anesthesia, saliva was aspirated before tracheal extubation. The mouth of the patient was kept open with a laryngoscope to prevent the tube tip from touching the tongue and all patients were extubated gently. Patients in whom extubation provoked bucking or coughing were excluded from this study. Then, the tip of the tracheal tube was sampled using sterile cotton swabs. All the equipments including the endotracheal tube, the laryngoscope and suction tube was manipulated in a sterile fashion.

The microorganisms obtained by swabbing were suspended in 1 mL of phosphate buffered saline by vortexing for 20 sec; 100 μL of these suspensions were

then inoculated onto nutrient agar plates (Nissui Pharmaceutical Co., Ltd., Tokyo, Japan). After a two-day incubation at 37°C, the number of colony forming units (CFUs) was counted to give the overall number of bacteria. Based on the number of colonies, the patients were classified into four levels of bacteria carriage: level 1 (0 to 9 CFUs); level 2 (10 to 99 CFUs); level 3 (100 to 999 CFUs); level 4 (over 1000 CFUs). The bacteria were replicated onto both yolk salt agar (Nissui Pharmaceutical Co., Ltd., Tokyo, Japan) and MRSA screening agar (Nippon Becton Dickinson Co., Ltd., Tokyo, Japan); the latter contained 6 μg of oxacillin per litre and 4% NaCl. These plates were incubated overnight at 37°C, and methicillin-resistant lipase-producing colonies were presumptively identified as MRSA. MRSA was confirmed by gram staining, an agglutination test for protein A and clumping factor (Staphylo LA; Denka Seiken, Tokyo, Japan), and amplification of the mecA gene by polymerase chain reaction.[15]

Statistics
All results are expressed as mean ± standard deviation. The following statistical tests were used: for comparison of patient characteristics including age, body weight, and duration of anesthesia and surgery, a Student t test was performed. The Mann-Whitney U test was used for multiple paired comparisons. A P value < 0.05 was considered statistically significant.

Results
The study population consisted of 38 patients: 19 patients gargled with povidone-iodine (gargling group), while the remaining 19 patients did not (control group). There were no significant differences between the groups by age, body weight, gender distribution, or duration of anesthesia and surgery (Table I).

Before orotracheal intubation, all 19 patients who gargled with tap water (control group) showed bacterial colonization in the pharynx, and in 45% of the patients (eight patients) colonization was at level 3 or 4 (Table II). MRSA in the pharynx was isolated in four (21%) of the five patients who had MRSA in the nasal cavity preoperatively.

All 19 patients who gargled with povidone-iodine (gargling group) also showed bacterial colonization. However, the degree of bacterial colonization was lower than in the control group: all patients were at level 1 or 2 (P < 0.01). In this group, four patients (21%) carried MRSA in the nasal cavities preoperatively, but no MRSA was detected in the pharynx.

Next, we studied the bacterial contamination of the tip of the tube after extubation. In the control group,

TABLE I Patient characteristics

	Control group	Gargling group
n	19	19
Age (yr)	57.4 ± 16.0	57.6 ± 16.0
Sex (female/male)	11/8	11/8
Duration of operation (min)	164.9 ± 124.9	158.4 ± 66.7
Duration of anesthesia (min)	250.3 ± 152.3	235.8 ± 69.3
MRSA carriers	5	4

No statistical difference between the two groups. MRSA = methicillin-resistant *staphylococcus aureus*.

TABLE II The effects of gargling with povidone-iodine on bacteria transport

Degree of bacterial colonization	Control group no (%) All bacteria	MRSA	Gargling group no (%) All bacteria	MRSA
Posterior wall of the pharynx				
Level 1	7 (36.8)	0 (0)	14 (73.7)	0 (0)
Level 2	4 (21.1)	2 (10.5)	5 (27.3)	0 (0)
Level 3	5 (26.3)	1 (5.3)	0 (0)	0 (0)
Level 4	3 (15.8)	1 (5.3)	0 (0)	0 (0)
Tip of the tracheal tube				
Level 1	7 (36.8)	0 (0)	16 (84.2)	0 (0)
Level 2	7 (36.8)	0 (0)	3 (15.7)	0 (0)
Level 3	4 (21.1)	2 (10.5)	0 (0)	0 (0)
Level 4	1 (5.1)	0 (0)	0 (0)	0 (0)

CFUs/plate

The Mann-Whitney's U test was used for multiple paired comparisons. Degree of bacterial colonization in the gargling group was lower than in the control group (P < 0.01). MRSA = methicillin-resistant *staphylococcus aureus*; CFU = colony forming units.

four patients (21.1%) had level 3 colonization and one patient (5.1%) had level 4 (Table II). MRSA was detected in two patients (10.5%). In the gargling group, colonization was level 1 or 2 in all patients and no MRSA was detected at the tip of the tube (Table II). Gargling with povidone-iodine reduced the number of bacteria at the tip of the tube more than in the control group (Table II).

Discussion
In this study, after gargling with povidone-iodine, the number of bacterial colonies in the pharynx was lower than after gargling with tap water. These results are consistent with previous findings.[12–14] Especially, no MRSA was detected after gargling with povidone-iodine. In our study, gargling with povidone-iodine was performed about 30 min before anesthesia. In their *in vitro* study, Reimer *et al.* (2002) demonstrated the bactericidal efficiency (logarithmic reduction factor value > 5) in respect of MRSA after 30 sec expo-

sure of povidone-iodine.[16] Additionally, Fuursted *et al.* (1997) showed that the mean duration of lag of regrowth on bacterial species was about 1.6 hr after exposure to 0.5% povidone-iodine for two minutes.[17] Thus, our protocol was adequate to evaluate the efficacy of povidone-iodine before general anesthesia. Our results show that gargling with povidone-iodine reduces the growth of bacteria, including MRSA, in the pharynx.

Continuous subglottic aspiration could reduce the incidence of pneumonia associated with mechanical ventilation since oropharyngeal secretions available for aspiration would be limited.[9,18] During general anesthesia, endotracheal intubation prevents aspiration, although pooled secretions above of the endotracheal tube cuff facilitate bacterial overgrowth and aspiration after extubation.[18] In this study, we sampled the endotracheal tube since we focused on the possibility of micro aspiration of potentially pathogenic microorganisms from the oropharynx just after extubation.

Further, the gargling group had fewer bacteria at the tip of the tracheal tube than the control group. The number of bacteria at the tip of the tube was proportional to the number in the pharynx. These results suggest that gargling with povidone-iodine reduces bacterial transport from the pharynx by reducing the number of bacteria in the pharynx. This is the first report of the efficacy of gargling in reducing bacterial transport into the trachea. We speculate that a decrease in the number of bacteria in the pharynx before general anesthesia may reduce upper airway infection due to general anesthesia, but we did not compare the rate of pneumonia after anesthesia between the two groups in this study. We identified MRSA since MRSA is a nosocomial pathogen of great concern in hospitals worldwide. Identification of other pathological microorganisms in the pharynx and the trachea will be necessary to evaluate the efficacy of gargling with povidone-iodine. Further studies will be necessary to answer these questions. For prevention of NP, it has been reported that selective digestive decontamination (SDD) would prevent infection by eradicating and preventing carriage of potentially pathogenic aerobic microorganisms from the oropharynx.[19,20] Although this technique reduces the frequency of NP, SDD is not routinely recommended because of cost and risk of increasing bacterial resistance and drug toxicity.

We showed that oral gargling with povidone-iodine is a simple, effective maneuver for disinfecting the upper respiratory tract prior to anesthesia and surgery. However, povidone-iodine can cause cytotoxic reactions.[21] Prolonged exposure to povidone-iodine solution may cause irritation or severe skin reactions.[22] The safety of povidone-iodine preparations applied to the nasal mucosa and other mucous membranes has been well described.[12–14,16] We used a single application of povidone-iodine before anesthesia and observed no adverse event. Nevertheless, care should be taken when using povidone-iodine solution, especially with regard to allergic reactions.

In conclusion, we demonstrated that gargling with povidone-iodine reduced the number of microorganisms in the pharynx and bacterial transport into the trachea. Povidone-iodine gargling may reduce the risk of infectious complications associated with endotracheal intubation.

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