Efficacy of rubber dam isolation as an infection control procedure in paediatric dentistry

Azza Mahmoud Tag El-Din [1] and Nagwa Abd El-Hady Ghoname [1]

كفاءة استخدام الحاجز المطاطي كوسيلة للتحكم في انتقال العدوى بوحدة علاج أسنان الأطفال

عزة محمود تاج الدين ونجوى عبد الهادي غنيم

خلاصة: أجري هذا البحث لتقييم كفاءة استخدام كل من الحاجز المطاطي والمضمضة المطهرة للفم، واستخدامهما معاً، في تقليل التلوث الجرثومي للهواء أثناء المعالجة التحفظية بوحدة علاج أسنان الأطفال في كلية طب الأسنان بجامعة طنطا. ولقد وجد اختلاف في توزع التلوث الجرثومي بحسب موقع السن المعالجة في فم المريض. ووجدت أعلى نسبة من التلوث الجرثومي المنقول بالهواء، على أطباق المزارع الموضوعة على صدر المريض. ولوحظ انخفاض الجراثيم بنسبة 98.8% على مسافة متر عند استخدام الحاجز المطاطي. وارتفعت هذه النسبة عند استخدام المضمضة المطهرة قبل تركيب الحاجز المطاطي. ولوحظ انخفاض التلوث الجرثومي بشدة كلما بعدت المسافة عن دعامة الرأس.

ABSTRACT The efficacy of rubber dam, antiseptic mouth rinse and both procedures together in controlling atmospheric bacterial contamination during conservative procedures in the paedodontic clinic at Tanta University was assessed. Distribution of bacterial contamination varied depending on the position of the tooth in the mouth. The highest airborne bacterial contamination was found on the plates positioned on the patient's chest. There was 98.8% bacterial reduction at 1 metre when rubber dam was used. This reduction increased when antiseptic mouth rinse was used before rubber dam application. Bacterial contamination fell sharply with increased distance from the head-rest.

Efficacité de l'isolation par digue caoutchoutée en tant que procédure de lutte contre l'infection en dentisterie infantile

RESUME Il s'agit d'une évaluation de l'efficacité des digues caoutchoutées, des bains de bouche antiseptiques et des deux procédures appliquées parallèlement dans la lutte contre la contamination bactérienne atmosphérique au cours des procédures de traitement conservateur à la clinique de pédodontie de l'Université de Tanta. La distribution de la contamination bactérienne variait selon la position de la dent dans la bouche. La contamination bactérienne aérogène la plus forte a été trouvée sur les plaques positionnées sur le thorax des patients. Il y a eu une diminution de 98,8% des bactéries à un mètre lorsque la digue caoutchoutée était utilisée. Cette diminution était plus importante lorsque des bains de bouche antiseptiques étalent utllisés avant l'application des digues caoutchoutées. La contamination bactérienne diminuait fortement à plus grande distance de l'appui-tête.

[1] *Lecturer in Paedodontics, Faculty of Dentistry, Tanta University, Tanta, Egypt.*
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Introduction

The increase in scientific data and awareness of the problems concerning indoor pollution has led to a series of studies aimed at identifying and measuring the factors that can alter the quality of air in an enclosed environment. The dental office deals with specialized pollution produced by blood spilling procedures on a vast population likely to be affected by numerous diseases. In addition, dental procedures are performed with aerosol-creating instruments inside the oral cavity, which is highly contaminated with a wide and still partially unknown range of bacterial flora [*1–3*].

Previous studies have shown that microorganisms in the mouth and respiratory tract can be transported in the aerosols and spatter generated during dental procedures and can contaminate the skin and mucous membrane of the mouth, respiratory passages and eyes of dental personnel. In addition, they can spread contamination onto the inert surfaces found throughout the dental clinic [*4–7*].

Fine aerosols generated by high-speed dental equipment consist of moisture droplets and debris, usually 5 µm or less in diameter, that can remain suspended in the air. Without adequate protection, aerosols may reach the depth of the lungs [*8,9*]. Spatter droplets are much larger than aerosol particles (≥ 50 µm in diameter) and can act as projectiles. Both aerosol particles and spatter droplets can contain infectious agents as the diameter of a bacterial cell is about 1.0 µm and that of a virus much smaller [*10*].

According to the American Dental Association Research Institute, there are about 40 infectious hazards for the patient and dental personnel in the dental surgery [*11*]. The most important are influenza, tuberculosis, oral lesions, conjunctivitis due to *Neisseria gonorrhoeae*, syphilitic lesions, hepatitis A–E, parotitis, meningitis due to the mumps virus, and acquired immunodeficiency syndrome (AIDS) [*12–16*].

It is reasonable to assume, therefore, that any method for reducing the viable bacterial content of aerosols could lower the risk of cross-contamination in dental clinics. The aims of the present work were to:

- evaluate quantitatively the changes in atmospheric bacterial pollution when conservative procedures were performed in a paedodontic clinic;
- compare the efficacy of rubber dam and antiseptic mouth rinsing in reducing bacterial contamination.

Materials and methods

The study was carried out in a dental partition measuring 2 × 3 m in the paedodontic clinic at the Faculty of Dentistry, Tanta University. The study included 20 children, aged from 5 to 10 years, who required restorations on adjacent anterior or posterior teeth. The posterior teeth were restored with amalgam and anterior teeth with composite. Two different methods of bacterial reduction were used in each child. Adjacent lesions were restored at appointments at least one week apart.

The operative procedures were performed in the morning to minimize aerosol particle contamination of the environment. An air-turbine-driven handpiece was used and the patient was seated in a reclining position. The length of the procedure varied from 5 to 15 minutes. The windows of the dental partition were opened prior to the procedure to ventilate the partition but were closed 30 minutes before recording

background levels of atmospheric bacteria. The selection of the bacterial reduction method, the restoration of the caries tooth and the appointment were randomized and divided into four groups:

- conservative procedures performed under rubber dam isolation;
- chlorhexidine mouth rinsing 30 minute before starting the conservative procedure;
- chlorhexidine mouth rinsing before application of the rubber dam;
- conservative procedures performed without rubber dam isolation.

Four blood agar culture plates were placed equidistantly from the child's head, one each on the chest, on the left and right sides and behind the patient. Another two plates were placed 1 metre and 2 metres from the head-rest of the dental chair. Preoperative microbial pollution was measured by exposing the blood agar plates to the air for 10 minutes. Fresh plates were placed in identical positions during the operative procedure to determine the perioperative bacterial counts in the different groups. A third set of plates was exposed to the air for about 10 minutes after restoration completion to evaluate the postoperative bacterial contamination. All plates were incubated aerobically at 37 °C for 48 hours. The resultant number of colony-forming units (CFUs) represented the level of airborne bacterial content. Significance of difference was tested using the *t*-test or *F*-test as appropriate.

Results

The distribution of bacterial contamination counts found around the child's head and on his/her chest during the operative procedure in different areas in the mouth is shown in Table 1; the distribution in different procedure groups is shown in Table 2. The variation in CFUs at different distances and operative stages in the four groups is shown in Table 3. The variation in bacterial contamination of the air at one metre during the different procedures is shown in Figures 1–4. Comparison of the techniques for the reduction of bacterial contamination is shown in Table 4.

The distribution of bacterial contamination differed during conservative procedure because of the different positions of the teeth. There was no significant difference in the background bacterial counts when

Table 1 **Mean bacterial counts around the child according to procedure site**

Procedure site	Colony forming units			
	Chest Mean ± *s*	Right side Mean ± *s*	Left side Mean ± *s*	Behind head Mean ± *s*
Right mandibular molar	28.8 ± 7.91	19.8 ± 5.98	17.6 ± 3.75	11.8 ± 4.98
Left mandibular molar	31.0 ± 8.99	15.7 ± 5.76	10.0 ± 3.77	9.1 ± 3.11
Right maxillary molar	23.4 ± 5.10	21.4 ± 6.47	14.9 ± 2.43	13.6 ± 2.76
Left maxillary molar	24.5 ± 4.50	15.4 ± 2.59	24.8 ± 4.72	15.1 ± 2.69
Upper anterior	34.3 ± 4.69	15.5 ± 2.92	15.4 ± 3.03	14.9 ± 3.14

s = *standard deviation*
n = *10 for each site*

Table 2 **Mean bacterial counts around the child according to procedure group**

Procedure group	Colony forming units			
	Chest Mean ± *s*	Right side Mean ± *s*	Left side Mean ± *s*	Behind head Mean ± *s*
Rubber dam	10.1 ± 2.60	9.5 ± 3.31	6.3 ± 3.33	5.7 ± 1.89
Antiseptic	16.6 ± 4.97	15.67 ± 3.20	9.8 ± 2.78	7.1 ± 2.23
Rubber dam and antiseptic	8.3 ± 1.49	7.30 ± 1.64	3.6 ± 2.41	4.2 ± 2.53
Without rubber dam	28.8 ± 7.91	19.8 ± 5.98	17.6 ± 4.33	11.8 ± 4.98

n = *10 for each group*
s = standard deviation

Table 3 **Mean bacterial counts at different operative stages with distance and procedure**

Distance and procedure	Colony forming units			*F* value
	Preoperative Mean ± *s*	Perioperative Mean ± *s*	Postoperative Mean ± *s*	
Distance 1 metre				
Rubber dam	8.7 ± 2.87	8.9 ± 2.51	9.7 ± 1.77	0.475
Antiseptic	8.5 ± 2.76	12.8 ± 7.49	11.8 ± 3.91	5.224*
Rubber dam and antiseptic	8.6 ± 2.72	8.7 ± 2.54	9.4 ± 2.88	0.273
Without rubber dam	8.8 ± 3.65	25.1 ± 4.43	13.5 ± 4.45	41.589*
F value	0.002	62.611*	3.350*	
Distance 2 metres				
Rubber dam	8.9 ± 2.58	8.7 ± 1.42	9.1 ± 2.47	0.083
Antiseptic	8.9 ± 2.13	11.6 ± 2.41	10.2 ± 2.57	3.235*
Rubber dam and antiseptic	8.7 ± 1.57	8.9 ± 2.13	9.0 ± 2.62	0.059
Without rubber dam	9.4 ± 1.58	20.4 ± 6.50	11.3 ± 1.95	38.746*
F value	0.226	20.950*	28.770*	

n = *10 for each procedure* *s = standard deviation* * *Significant at 5% level*

preoperative and postoperative levels were compared at the 1 and 2 metre positions. However, there were significantly different bacterial counts at 1 metre and 2 metres when preoperative and perioperative or perioperative and postoperative procedures were compared in the group without rubber dam isolation.

The mean preoperative CFU count was subtracted from the perioperative mean and the percentage reduction in CFUs was calculated between the control group (without rubber dam isolation) and the three other groups. The reduction in CFUs at one metre was 98.8%, 73.8% and 99.4% in the rubber dam group, the antiseptic group and the antiseptic with rubber dam group respectively. Bacterial contamination almost disappeared for the rubber dam group and for the antiseptic with rubber dam group at

Table 4 **Efficacy of techniques for reduction of bacterial contamination**

Comparison	*P* value		
	Preoperative	Perioperative	Postoperative
Rubber dam vs without rubber dam			
1 metre	NS	< 0.05	< 0.05
2 metres	NS	< 0.05	NS
Rubber dam vs antiseptic			
1 metre	NS	< 0.05	NS
2 metres	NS	< 0.05	NS
Antiseptic vs without rubber dam			
1 metre	NS	< 0.05	NS
2 metres	NS	< 0.05	NS
Antiseptic vs rubber dam and antiseptic			
1 metre	NS	< 0.05	NS
2 metres	NS	< 0.05	NS
Rubber dam and antiseptic vs without rubber dam			
1 metre	NS	< 0.05	< 0.05
2 metres	NS	< 0.05	< 0.05
Rubber dam and antiseptic vs rubber dam			
1 metre	NS	NS	NS
2 metres	NS	NS	NS

NS = not significant at 5% level

2 metres while the reduction in the antiseptic group was 75.5%.

Discussion

Occupationally-acquired infections, especially many of the respiratory tract viruses which are highly infectious, are a recognized hazard for health care workers, including dentists. In this era of concern about infectious diseases in the dental clinic, it is of utmost importance to consider all methods that can minimize the risk of transmission of potentially infectious agents to dentists, dental auxiliaries and patients.

The present study took place in a university paedodontic clinic, consisting of 10 partitions, which operates 5 hours a day, 6 days a week. During conservative procedure without rubber dam, which involved 5 to 15 minutes work on the patient, the airborne bacterial load increased from 8.8 to 25.1 CFUs. This means that the patient, dentist, assistant and the surfaces and objects in the clinic are at a risk of exposure to airborne contamination 2.5 times greater than the norm. A similar finding was reported by Legnani et al. who found an increase in the airborne bacteria three times greater than the norm [*1*]. We also found that the airborne bacteria after the procedure persisted at a higher level than the initial one

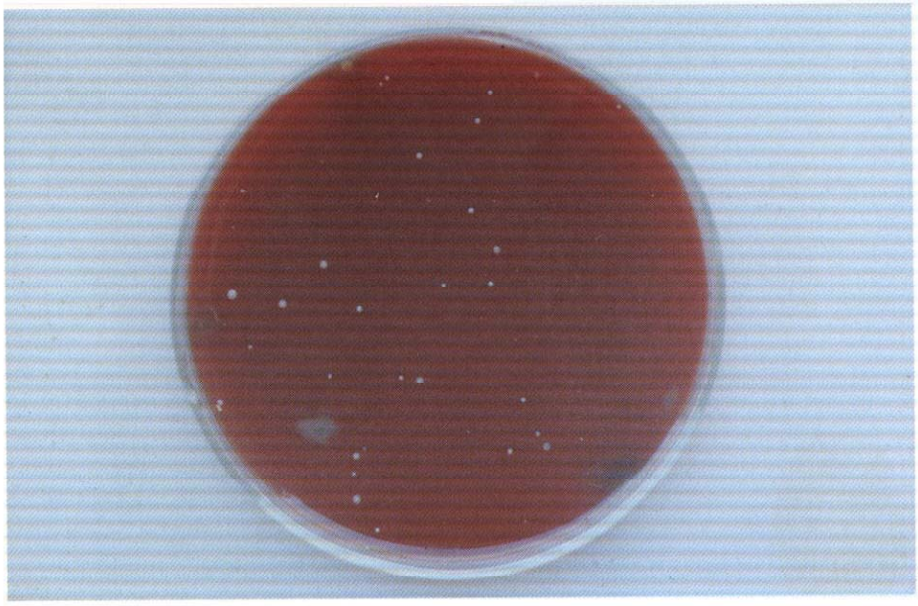

Figure 1 **Bacterial contamination of air during conservative procedure after rubber dam isolation**

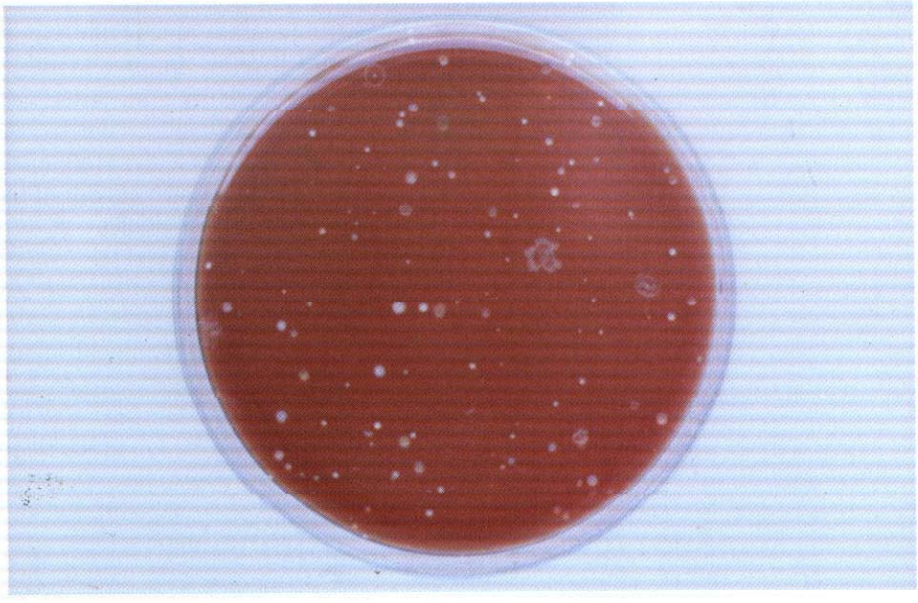

Figure 2 **Bacterial contamination of air during conservative procedure after antiseptic mouth rinsing**

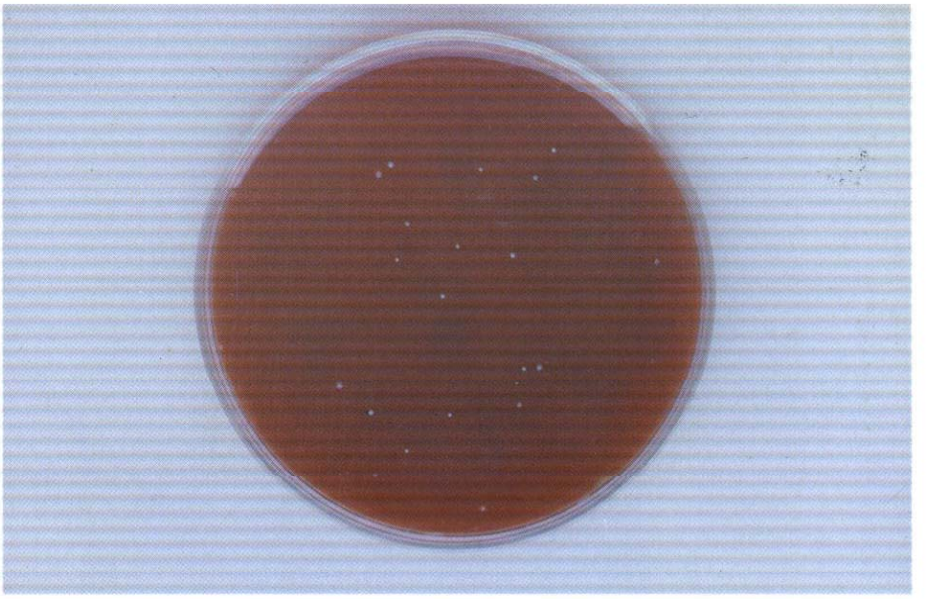

Figure 3 **Bacterial contamination of air during conservative procedure after antiseptic mouth rinsing and rubber dam isolation**

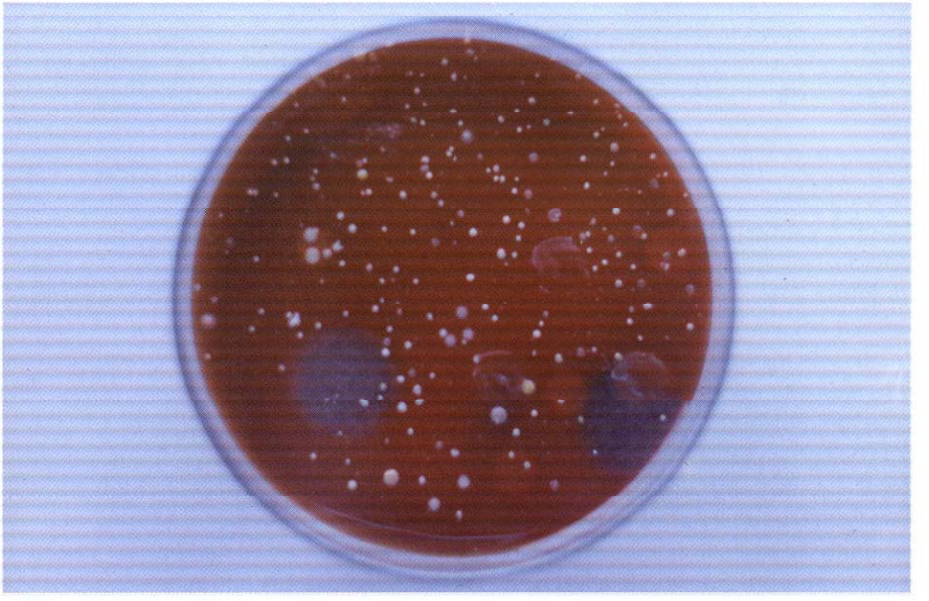

Figure 4 **Bacterial contamination of air during conservative procedure without rubber dam or antiseptic mouth rinsing**

(8.8 to 13.5 CFUs). This is in agreement with Legnani et al. [*1*] and other investigators [*2,4,5*], which suggests that after many patients have been treated, the microbiological contamination at the end of the day will be worse and many different species of bacteria may be present in a dental office. The contamination may become worse if using a high-speed handpiece in infected pulp containing variable species of anaerobic and aerobic bacteria.

During cavity preparation, there were variable distributions of bacterial-contaminated aerosols and spatter. The highest bacterial counts were detected on plates positioned on the patient's chest. This finding agrees with Cochran et al. [*10*] and Bentley et al. [*2*] who concluded that the larger salivary droplets generated during dental procedures settle rapidly from the air with heavy contamination of the patient's chest. The distribution of bacterial contamination when cavity preparation was performed in the mandibular molar regions suggested that the spatter radiated outward from the patient's mouth towards the chest and to the same side of the procedure. There was a different distribution of bacterial contamination when the procedure was performed in the maxillary teeth. Thus, the distribution is variable and may be influenced by many factors, such as the type of procedure, the position of the tooth in the mouth, the position of the operator relative to the patient, the position of the patient in the dental chair, whether high-volume evacuation was used and the level of microorganisms in the patient's mouth.

High-volume evacuation was not available during the present study, which may explain why the number of CFUs in the groups was higher than previous studies [*10,17,18*]. However, the number of CFUs at two metres was reduced, which could be attributed to window ventilation. The high variability in CFUs probably results from the variability in the number of oral microbes originally present in the patients' mouths [*10,19*]. Care was taken to standardize the microbial collection and culture procedures and to control environmental contamination on the plates. However, nothing could be done about quantitatively controlling the level of microbes in the patients' mouths, which may vary considerably.

The results of this study are comparable to those of other studies on the barrier efficiency of rubber dam [*8,10,20*]. Previous studies used short collection times of 15 seconds during the use of the air-turbine handpiece, whereas the present study involved collecting the microbial sample throughout the entire restorative procedure (5–15 minutes) as done by Cochran et al. [*10*].

The use of rubber dam, in addition to improving safety and saliva control, significantly reduces bacterial contamination of the atmosphere during conservative procedure, particularly in the vicinity of the operator and dental assistant [*6,8,10,16,19*]. The reduction of bacteria-laden aerosols near the operator was higher in the present study (98.8%) compared to 78% reported by Samaranayake et al. [*19*] and 70%–88% reported by Cochran et al. [*10*].

The preprocedure use of antiseptic mouth rinse (chlorhexidine) reduced the levels of bacteria (73.8%) produced during conservative procedure. Many investigators have reported percentage reductions ranging from 67.8% [*18,20*] to 94.1% [*17,21*]. The efficacy of chlorhexidine in controlling bacterial contamination has been attributed to its adposition to other oral structures (such as plaque pellicle, oral mucosa and hydroxyapatite) which become reservoirs for the slow release of chlorhexidine, thus prolonging its antimicrobial ef-

fect [3,22,23] and this effect persists even in the presence of blood or debris [24]. The virucidal activity of chlorhexidine has also been demonstrated *in vitro* against herpes simplex virus, cytomegalovirus, influenza A, parainfluenza and hepatitis B viruses [23]. The use of antiseptic mouth rinse before rubber dam isolation significantly reduced the level of bacterial contamination up to 99.4% in comparison with conservative procedures done without rubber dam. These findings are consistent with other methods of bacterial reduction such as high-volume evacuation [19] and preoperative tooth brushing [25] in reducing the airborne contamination.

There has been no direct evidence indicating that the spread of microorganisms during dental treatment is a major cause of infectious disease in dentists or patients. However, the possibility cannot be ignored, especially since increasing numbers of unrecognized infective patients are now seeking dental care. Therefore, it is important to identify exposure risks for dental personnel and vulnerable patients, to use protective barriers and to continue to seek procedural improvements to reduce exposure risks. More studies are warranted to evaluate the methods used to reduce atmospheric contamination, particularly by viral pathogens, such as human immunovirus (HIV), hepatitis B and respiratory viruses.

Conclusions

This study demonstrated that contamination from spatter and aerosol dissemination remains a significant hazard to dental personnel when high-speed equipment is used. The results highlight the importance of limiting environmental microbiological contamination and demonstrate the usefulness of rubber dam in reducing the spread of infectious agents in the dental office by providing barrier protection at the source of microbial contamination. The study provides additional evidence to support the recommendation for the preprocedure use of an antiseptic mouth rinse as a routine part of the infection control regimen.

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