

Effect of Chlorine Dioxide Gas of Extremely Low Concentration on Absenteeism
of Schoolchildren

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Abstract

Gas-generating devices of chlorine dioxide (ClO_2) are used as deodorant of rooms. We happened to use a commercial tabletop deodorant canister that releases extremely low-concentration ClO_2 gas in a school classroom as deodorant. We found retrospectively and unexpectedly that during a period of 38 consecutive school days the rate of schoolchildren absent from the school was markedly lower (1.5%) in a classroom where the ClO_2 device was placed than that (4.0%) in a classroom where it was not placed. The percentages of absenteeism between these classrooms (1.5% vs. 4.0%) were significantly ($p < 0.00001$) different. The predominant causes of absenteeism during the period were common cold and influenza. Judging from the known virucidal activity of ClO_2 , our unexpected finding in the school classrooms strongly suggests the usefulness of extremely low-concentration ClO_2 gas to prevent respiratory viral diseases in semi-closed areas, such as theaters, hospitals and aircraft, without necessitating evacuation.

Key Words

Chlorine dioxide · Absenteeism · Schoolchildren · Gas · Influenza · Respiratory infection ·

Virus

Introduction

Chlorine dioxide (ClO_2) is water-soluble gas at room temperature. It has long been used as a disinfectant of tap water (Betancourt et al., 2004), bleach (Moran et al., 1953) and deodorant (Loesche and Kazor, 2002). Owing to its strong oxidizing activity, it inactivates bacteria, fungi and viruses (Berg et al., 1982), (Morino et al., 2007), (Simonet and Gantzer, 2006). ClO_2 gas released from its aqueous solution has been used as a sanitizer and a deodorant of room air. We used a commercial tabletop deodorant ClO_2 gas-generating device in school classrooms.

When we used the device in a classroom, we found retrospectively and unexpectedly that during a period of 38 consecutive school days the rate of schoolchildren absent from the school was markedly lower in the classroom where the ClO_2 devices were placed than that in the classroom without the device. This unexpected observation strongly suggests usefulness of the device in preventing infectious, most probably respiratory, diseases in a community. The emerging threat of an influenza pandemic that may be spread rapidly by air travel is currently a serious global concern. The importance of our finding in terms of prevention of the spread of respiratory viral diseases, such as high-virulence avian influenza, in semi-closed areas, such as theaters, hospitals and aircraft, is briefly discussed.

Material and methods

A commercially available tabletop ClO₂ gas-generating device (Cleverin G, a canister of 150 g active ingredients) was used. The device releases gaseous ClO₂ in a sustained manner. Three of these devices were placed in a classroom with 65-m² floor area (230-m³ volume) and 34 schoolchildren for use as a deodorant. According to the manufacturer, the concentration of ClO₂ becomes 0.01-0.03 ppm in a classroom of this volume when that number of units is used. The statistical evaluation of the difference in the rate of absenteeism between two groups (schoolchildren in classrooms with or without the ClO₂ devices) was done by a χ^2 test, and the difference was considered significant at $p < 0.05$.

Results and discussion

When we used the device in a school classroom, we found retrospectively during the period of 38 consecutive school days that the rate of absenteeism (number of absent schoolchildren divided by a nominal number of schoolchildren in that particular classroom) during the period of 38 consecutive school days (from January to March) appeared lower in the classroom where the ClO₂ devices were placed compared to that in the classrooms where such devices were not placed (Figure 1). However, it was statistically unclear from Figure 1 whether the difference in the rate of absenteeism between the two groups was significant. Therefore, we calculated cumulative numbers of schoolchildren present or absent from school based upon the above data by summing up the daily number of schoolchildren present or absent for the entire 38 school days (Table 1).

The rate of absenteeism demonstrated by the cumulative number of schoolchildren absent from school was markedly lower in the classroom where the ClO₂ device was placed than that in the classrooms without the device. In the former classroom, the cumulative number of schoolchildren present was 1272 (98.5%), and that of schoolchildren absent was 20 (1.5%). On the other hand, in the latter classrooms, the cumulative number of schoolchildren present was 21634 (96.0%), and that of schoolchildren absent was 900 (4.0%). The percentages of absenteeism (1.5% vs. 4.0%) were significantly ($p < 0.00001$, χ^2

test) different. The predominant causes of the absenteeism in the entire school were influenza (24% of total diseases) and common cold.

The effect of the device on the lower rate of absenteeism appears to be due to the ClO₂ gas released from the device, since the only volatile materials released from the device are ClO₂ and water. Respiratory viral diseases, such as high-virulence avian influenza, are major public health concerns worldwide (Ginsberg et al., 2009). Due to the potential for rapid spread of such diseases via air travel, they could immediately result in pandemics with millions of fatalities. However, at present there are almost no effective countermeasures against such devastating infectious diseases in semi-closed areas, such as aircraft, tramcars and school classrooms. Judging from the known virucidal activity of ClO₂ (Zoni et al., 2007), our unexpected and retrospectively observed finding in school suggests the possible usefulness of extremely low-concentration ClO₂ gas to prevent the spread of respiratory viral diseases without necessitating evacuation. Based upon the serendipitous observation in a school, we conclude that ClO₂ gas at an extremely low concentration could potentially prevent diseases, such as respiratory infections, in semi-closed areas. Large-scale studies would be needed to substantiate further our important observation.

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Table 1. Cumulative numbers of schoolchildren present or absent from school

ClO ₂ device	Cumulative no. of schoolchildren	
	Present	Absent
Placed	1272 (98.5%)	20 (1.5%*)
Not placed	21634 (96.0%)	900 (4.0%*)

Numbers represent cumulative numbers of schoolchildren in classrooms with (one classroom) or without (17 classrooms) ClO₂ devices who were present or absent from school during 38 consecutive school days.

*Significantly different ($p < 0.00001$, χ^2 test).

Figure legend

Figure 1. Rates of absenteeism of schoolchildren. Rates of absenteeism (number of absent schoolchildren divided by a nominal number of schoolchildren in that particular classroom) in classrooms where ClO₂ gas-generating devices (Cleverin G) were (filled circles, one classroom) or were not (open circles, 17 classrooms) placed are shown.