■Concise communications

Decontamination of Environmental Surfaces of a Patient Room by Hydrogen Peroxide Vapourised

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Summary

Background : The environmental surface decontamination[1)] by hydrogen peroxide vaporized (HPV) is reevaluated in Europe and the United States for terminal disinfection of the patient room contaminated with microorganisms which cause crossinfections[2)]. The generator of HPV has different mechanisms from the generators of disinfectant splay or fogging in 1970s[3)]. In the results of previous study, log 10 reduction of the spores of *Geobacillus stearothemopilus* ATCC12980 (BI) was proved more than 6 when they were set on the surfaces[4)].

Objective : To evaluate the concentration of hydrogen peroxide (HP) vapour in the room during decontamination process and the influence of slight leak of door for the concentration of HP vapour in the outside corridor environment.

Methods : HPV was generated by HPV generator (Bioquell Z®, Bioquell) and the HPV concentrations were studied by an clectrochemical detcctor (Polytron 7000®, ,Draeger, sensitivity: 0-300 parts per million (ppm): uncertainty ≦±25% and 0-7000 ppm : uncertainty ≦±15%)

Results : The concentrations of HP vapour in the room during decontamination phase were around 200 ppm. The concentrations in outside air through the door leak during the decontamination phase were recognized to be much less than 1ppm 8 hour- time weighted average (TWA).

Conclusion : The concentrations of HP vapour during the decontamination phase in a almost 50m^3 room actually detected were a little lower than the dew points theoretically calculated[5)], but it is suspected that these our results obtained shows the real concentration of HP vapour during decontamination phase in practical situation for patient room. And from the view point of the patient safety in neighbour room of the ward, the outside concentrations of HPV through slight leak of door detected were tested and recognised to be 0.3ppm which is much less than permissible exposure limit of 1ppm 8 hour-TWA.

The pathogens persist on the inanimate surfaces of patient environments often cause the outbreaks of hospital infections[1,2)]. In 1970s, it is said that the splay or fogging of disinfectant is ineffective for environmental decontamination and adequate cleaning is much better than it[3)]. However recently vapourisation of disinfectant, not splay or fogging is being reevaluated for prevention of cross infection through inanimate surfaces in patient room. So, the efficacy of hydrogen peroxide vaporised (HPV) to decontaminate the pathogens on the inanimate surfaces was studied in previous report [4)]. This time the concentration of HPV in the room during decontamination process and the influence of slight leakage of HPV into outside of the room were evaluated.

1. Methods

Hydrogen peroxide (HP) vapour was generated by HPV generator (Bioquell Z®, Bioquell). HP vapour was evaporated into a room (451cm wide, 455 depth and 239cm height = 49.04 m^3), and the concentrations in the room and outside corridor were continuously measured by an electrochemical detector (Polytron 7000®, Draeger, sensitivity: 0-300 parts per million (ppm): uncertainty ≦ ±25% and 0-7000 ppm : uncertainty ≦±15%). HPconcentrations were recorded as maximum value for each sampling time. The concentration through slight leak of door was tested as shown in Figure 3 in order to evaluate the risk of leakage vapour in clinical setting.

2. Results

The concentrations of HPV in the room air during the process are shown in Figure 1 and 2 which were a little lower than the calculated dew point[5]. Hydrogen peroxide concentrations in the outside corridor 70cm apart from door slightly opened (7mm) as demonstrated in Figure 3 is shown in Figure 4 and 5. The 8 hour-time weighted average (TWA) of HP through the door leak was less than 1ppm (0.3ppm).

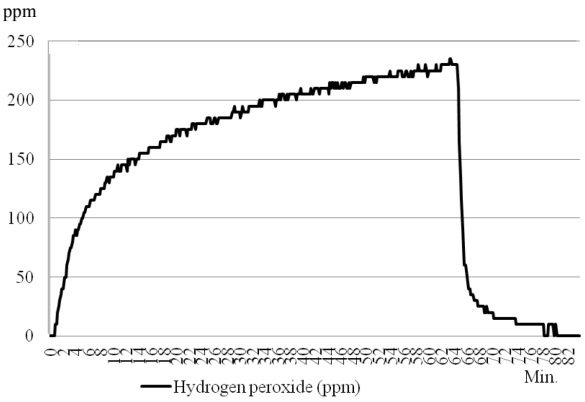


Figure 1. Hydrogen peroxide concentrations during vapour decontamination in the room.

The concentrations were detected every 10 sec.

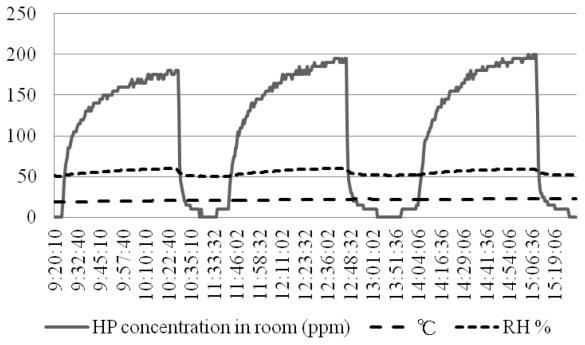
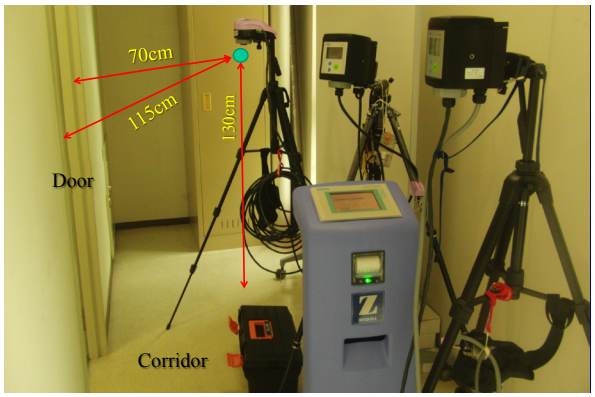


Figure 2. Hydrogen peroxide concentrations detected every 30 seconds during HP vapour decontamination in the room.

Decontamination processes were repeated three times with about 50 min. intermissions between them.
Room temperature : Ca 20-22℃ RH : Ca60% at the highest concentration
∴ Dew point of HPV at the condition calculated by Parks M, et al.[5] is approximately 350ppm.



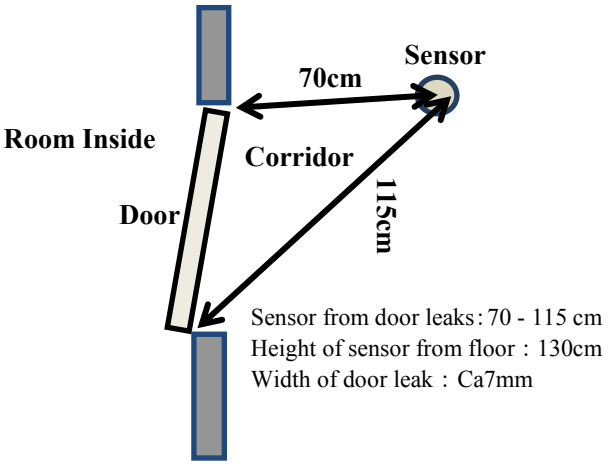


Figure 3. Detection of leaked hydrogen peroxide vapour outside into the corridor.

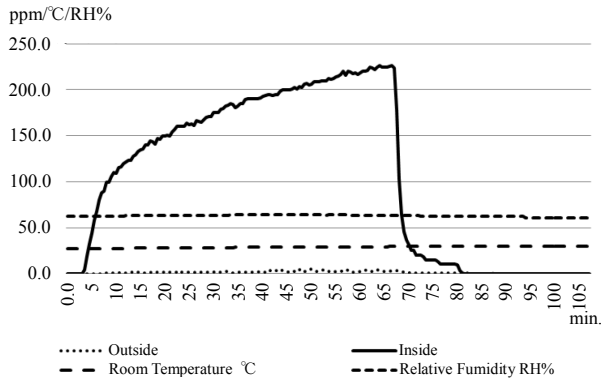


Figure 4. Hydrogen peroxide concentration (ppm) inside and outside of the room, and inside temperature (℃) and relative humidity (%) were detected every 30 seconds.

Room temperature : Ca30℃ RH : Ca64%
∴ Dew point of HPV at the condition calculated by Parks M, et al [5] is approximately 500ppm.

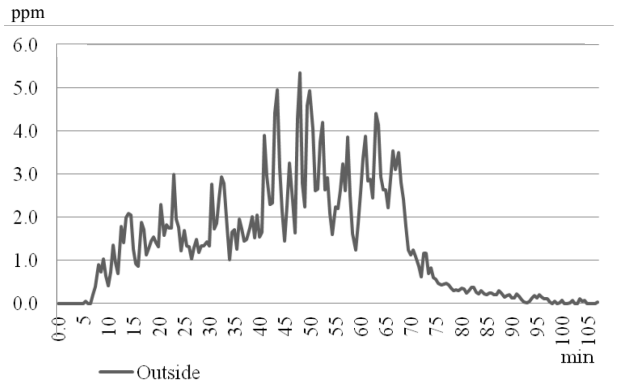


Figure 5. Hydrogen peroxide concentration in the outside corridor 70cm apart from door slightly opened (7mm)

Mean during 2hrs＝1.2ppm
∴8 hr-TWA＝1.2×2÷8＝0.3ppm

3. Discussion

Isolation

Recently the reports on surface decontamination of patient environments by hydrogen peroxide vapourised have increased in number. In those reports, the isolation number of methicillin-resistant *Staphylococcus aureus* (MRSA) has decreased in patient environments and operating rooms[6], outbreak of *Serrataia marcescens* infections in neonatal intensive care unit (NICU) has been successfully eliminated [7].

In the study of university-affiliated hospital with 200 beds, 27% of 350 surfaces sampled in the room of affected patients with MRSA were contaminated by them[8]. In the results of investigation in a 1200-bed London teaching hospital where MRSA colonization and infection is common, seventy-four percent of 359 swabs taken before cleaning yielded MRSA, 70% by direct plating. After cleaning, all areas remained contaminated, with 66% of 124 swabs yielding MRSA, 74% by direct plating. In contrast, after exposing six rooms to HPV, only one of 85 (1.2%) swabs yielded MRSA[9]. In another instance in a 20-bed Nightingale-design surgical ward, conventional deep cleaning did not eradicate environmental MRSA, but decontamination using HPV provides a rapid and cost-effective method for the eradication of environmental MRSA[10].

Many kind of strains are shown to survive more than 3 to 4 weeks up to 6 weeks which are able to be eradicated by HPV in 90 min[11]. Several reports demonstrated the efficacy of HPV for the decontamination of environmental contaminations[12-19].

However only a few reports on the concentration of HP vapour during decontamination phase are found [5,21,22]. This time HP vapour concentrations during the decontamination phase in practical situation of a room with internal volume of 49.04m^3 were actually investigated. The concentrations in our results are a little lower than the theoretically calculated dew point[5] and the concentration studied in the isolator with internal volume of 7.5m^3 experimentally[21], but much higher than the concentrations tested in a room having an area of 50.1m^3 with additional 13.2m^3 for side room [22].

In our study also the leakage of HP vapour through slight space of door artificially made was detected which is supposed a little leakage of HP vapour during the decontamination phase in clinical setting. In the result the leakage concentrations of HP vapour were recognised to be much lower than the recommended permissible exposure limit of 8 hr-TWA.

In conclusion, though there shows some difference of the HP vapour concentration between those we detected in this study and the dew points theoretically calculated[5] or the concentration in test isolator[21], it is suspected that these our results obtained by the best continuous detecting method in present days shows the real concentration of HP vapour during decontamination phase in practical situation for patient room. And this decontamination procedure should be safely performed in the ward with inpatients in neighbour rooms.

■Reference

1) Kramer A, Schwebke I, Kampf G. How Long Do Nosocomial Pathogens Persist on Inanimate Surfaces? A Systematic Review. *BMC Infect Dis* 2006;6:130.
2) Otter JA , French1 GL. Survival of Nosocomial Bacteria and Spores on Surfaces and Inactivation by Hydrogen Peroxide Vapor. *J Clin Microbiol* 2009; 47: 205-207.

3) Spaulding EH. Chemical Disinfection and Antisepsis in the Hospital. *J Hosp Res* 1972;9(Supersedes Vol 3(1) 1965).
4) Kobayasi H, Yoshida R, Kajiura T, Sogawa Y. Decontamination of Environmental Surfaces of Patient Room by Hydrogen Peroxide Vapourised. *J Healthcare-Ass Infect* 2010; 3:15-18.
5) Parks M, Walting D. The Relationship between Saturated Hydrogen Peroxide, Water Vapour and Temperature. *Pharm Tech Eur* 2004; Mar 1, 2004. http://www.pharmtech.com/pharmtech/article/articleDetail.jsp?id=88899&pageID=1&sk=&date= Accessed on 18 April 2012
6) Jeanes A, Rao G, Osman M, et al:Eradication of persistent environmental MRSA. *J Hosp Infect* 2005;61:85-86.
7) Bates CJ, Pearse R. Use of hydrogen peroxide vapour for environmental control during a Serratia outbreak in a neonatal intensive care unit *J Hosp Infect* 2005;61:364-366.
8) Boyce JM, Potter-Bynoe G, Chenevert C, et al:Environmental contamination due to methicillin- resistant *Staphylococcus aureus*: possible infection control implications. *Infect Control Hosp Epidemiol* 1997;18:622-627.
9) French GL, Otter JA, Shannon KP, et al: Tackling contamination of the hospital environment by methicillin-resistant *Staphylococcus aureus* (MRSA): a comparison between conventional terminal cleaning and hydrogen peroxide vapour decontamination. *J Hosp Infect* 2004;57:31-37.
10) Jeanes A, Rao G, Osman M, et al:Eradication of persistent environmental MRSA. *J Hosp Infect* 2005;61:85-86.
11) Otter JA, French GL:Survival of Nosocomial Bacteria and Sporeson Surfaces and Inactivation by Hydrogen Peroxide Vapor .*J Clin Microbiol* 2009;47:205･207.
12) Heckert RA, Best M, Jordan LT, et al:Efficacy of vaporized hydrogen peroxide against exotic animal viruses. *Appl Environ Microbiol* 1997;63:3916-3918.
13) Johnston MD, Lawson S, Otter JA. :Evaluation of hydrogen peroxide vapour as a method for the decontamination of surfaces contaminated with *Clostridium botulinum* spores. *J Microbiol Methods*. 2005;60:403-411.
14) Hall L, Otter JA, Chewins J, et al:Use of hydrogen peroxide vapor for deactivation of *Mycobacterium tuberculosis* in a biological safety cabinet and a room. *J Clin Microbiol* 2007;45:810-815.
15) Kahnert A, Seiler P, Stein M, et al : Decontamination with vaporized hydrogen peroxide is effective against *Mycobacterium tuberculosis*. *Lett Appl Microbiol* 2005;40:448-452.
16) Boyce JM.:New approaches to decontamination of rooms after patients are discharged. *Infect Control Hosp Epidemiol* 2009;30:515-517.
17) Bates CJ, Pearse R. : Use of hydrogen peroxide vapour for environmental control during a Serratia outbreak in a neonatal intensive care unit *J Hosp Infect* 2005;61:364-366.
18) Ray A, Perez F, Beltramini AM, et al:Use of vaporized hydrogen peroxide decontamination during an outbreak of multidrug-resistant *Acinetobacter baumannii* infection at a long-term acute care hospital. *Infect Control Hosp Epidemiol* 2010;31:1236-1241.
19) Otter JA, Yezli S, Schouten MA, van Zanten AR, Houmes-Zielman G, Nohlmans-Paulssen MK.:Hydrogen peroxide vapor decontamination of an intensive care unit to remove environmental reservoirs of multidrug-resistant gram-negative rods during an outbreak. *Am J Infect Control*. 2010;38:754-756.
20) Boyce JM, Havill NL, Otter JA, et al:Impact of hydrogen peroxide vapor room decontamination on *Clostridium difficile* environmental contamination and transmission in a healthcare setting. *Infect Control Hosp Epidemiol* 2008;29:723-729.
21) Unger-Bimczok B, Kottke V, Hertel C, Rauschnabel J:The Influence of Humidity, Hydrogen Peroxide Concentration, and Condensation on the Inactivation of *Geobacillus stearothermophilus* Spores with Hydrogen Peroxide Vapor. *J Pharm Innov*.2008;3:123･133.
22) Fu TY, Gent P, Kumar V. Efficacy, efficiency and safety aspects of hydrogen peroxide vapour and aerosolized hydrogen peroxide room disinfection systems. J Hosp Infect 2012; 80: 199-206.