ORIGINAL ARTICLE

A COMPARATIVE STUDY OF OPERATION THEATRE DISINFECTION BY FUMIGATION USING DIFFERENT COMPOUNDS

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ABSTRACT

Background and Objective: Objective of this study was i) to evaluate the efficacy of formalin and quaternary ammonium compounds (QUAT). ii) To compare the efficacy of both agents/techniques for operation theatre disinfection. This was an interventional, Case control study. This study was conducted at Children Hospital & Institute of Child Health Sciences, general operation theatre.

Method: A total of 200 samples were collected out of which 80 samples (plates as well swabs) were collected before and after formalin fumigation and 120 samples prior and after spray fogging using QUAT based compound. The samples were cultured on blood and Mac-Conkey agar. Identification and isolation was performed in microbiology department according to bacteriological standards.

Results: During fumigation by formaldehyde 34.3% samples (n = 32) were pre positive while 21.9% samples were post positive on different surfaces. On the other side 47.9% samples (n = 48) were pre positive while only 18.7% samples were post positive on different surfaces. Average bacterial count of air reduced from 744 (21 cfu/m^3) to 329 (9 cfu/m^3) after formalin vapor and 858 (25 cfu/m^3) reduced to 492 (14 cfu/m^3) after fogging.

Conclusion: This study showed that fogging by less toxic compounds takes less time and has fewer disadvantages if we use automatic equipment having fine particle size.

Key Word: Fumigation, Effectiveness, Quaternary ammonium compounds, Formaldehyde.

INTRODUCTION

Chemical Fumigation in Health care facilities has been widely used because environment plays an important role in Health-Care Associated Infections.[1] Methods of room cleaning used in operation theatres usually involve cleaning and disinfection using mopping.[2] Disinfectants play an important role in infection control policies and considered to be the most crucial weapon against transmission chain of microbes.[3] Besides all these regimens of cleaning and disinfection, continuous environmental monitoring should be done[4]. Environmental monitoring involves microbial testing of air, surfaces and different devices which come in contact of patient and Health care workers.[5] Bacterial count of operating room should not exceed 35cfu/m^3 with less than 1 colony of coagulase negative Staphylococci and staphylococcus aureus at all swabs and plates.[6] Formaldehyde disinfection is the most convenient and efficient method. Fumigation was used in addition to standard environmental surface disinfection in hospital rooms and critical care areas.[7] Formaldehyde was used for over 100 years and its efficacy remains controversial. Factors contributing to efficacy of formaldehyde range from humidity, temperature, concentration and procedure used.[8] Till 1988 formaldehyde is consider a substance of hazard to health as specified in schedule 1 of British control of substances hazardous to health. Formalin is explosive, highly toxic, corrosive, volatile irritant to eyes and especially carcinogenic.[9] Due to its carcinogenicity use of formaldehyde fumigation became questionable. Many facilities started using spraying of disinfectants on surfaces using protective mask, goggles and protective clothing because spray can penetrate and reach all surfaces which are difficult to clean.[2] Previous studies indicate that spray fog technique using quaternary ammonium disinfectant is useful adjunct for antimicrobial control.[10] However, the Centre for Disease Control and prevention (CDC) does not recommend disinfectant fogging for routine purposes in patient care areas.[10] But in 2001 after anthrax bioterrorism attack, fumigation techniques including fogging were again used to destroy bacteria and spores.[1] New range of chemicals like chlorine dioxide, hydrogen peroxide vapor (HPV), super-oxidized water and ozone were used for terminal cleaning of hospitals using were fogging, vapor and dry mist techniques.[2] The efficacy of 3rd generation quaternary ammonium compounds and formaldehyde for fumigation

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of operation theatres was compared in 2013 in India by Mishra and colleagues. Later on at different time intervals world over different approaches were adopted and tested for their efficacy. A meta-analysis was published for guidelines to reduce the microbial agents on hospital surfaces and air.[11-13]

MATERIAL AND METHODS:

i) **Study Design:** This was an interventional; Case control study. ii) **Sample Size:** Sample size was 200 collected before and after applying successive techniques. iii) **Location:** This study was conducted at Children Hospital and Institute of Child Health Sciences, general operation theatre.

Methodology

For each 1000/cu ft, 500ml of formalin with 1000ml of water were mixed and allowed to boil. After initiation of formalin vapor, the room was left and sealed. After the fumigation process, the formalin vapors were neutralized with 250ml of 10% ammonia for 1000/cu ft. The ammonia solution was placed in the center of the room and left for 3hours. Mixed quaternary ammonium based compounds 4 hour concentration (2.5 ml/liter) was used and fogging was done manually. After rooms were left for 4 hours. Post sampling was done after 4 hours and samples were incubated for 24 hours. After which bacteria were isolated and counted according to standard bacteriological techniques.

RESULTS

The results collected were as follows.

Samples from Surfaces: In formalin fumigation technique out of 32 total samples collected (n = 32), the pre fumigation samples were positive in 11 (34.3%), while in post fumigation, 7 (21.9%) were positive for growth. The details are shown in table 1.

On the other hand, in fogging technique out of 48 samples collected, 23 (47.9%) were positive for pre fumigation and only 9 (18.7%) were positive after applying fogging. The details are shown in Table 2.

Samples from Air: For environmental sampling viable bacterial counts of different rooms of operation theatres were noticed monthly. The monthly pre and post count of air mentioned as 1st, 2nd, 3rd and 4th cycles are listed in table 3. The average bacterial counts of 744 (21 cfu/m3) was reduced to 329 (9 cfu/m) after formalin processing. In contrast the average count of 858 (25 cfu/m3) reduced to 492 (14 cfu/m3) after fogging. Furthermore for comparison purpose paired sample T-test was applied on bacterial counts (P-value for formalin fumigation =0.098 while P-value for fogging = 0.07) (Table 3). This shows no significant difference in both techniques.

Table 1: *Frequency of growth obtained from different surfaces in pre and post formalin fumigation technique.*

Sampling	*Pre Fumigation*		*Post Fumigation*	
	Growth	*No Growth*	*Growth*	*No Growth*
Operation Table (n = 8)	2	6	4	4
Walls (n = 8)	1	7	1	7
Anesthesia Machine (n = 8)	2	6	1	7
Sucker Bottle (n = 8)	6	2	1	7
Patient Bed with Mattress (n = 0)	-	-	-	-
Oxygen Flow Meter (n = 0)				
Total	11 (34.3%)	21 (65.6%)	7 (21.9%)	25 (78.1%)

Table 2: *Frequency of growth obtained from different surfaces in pre and post fogging by mixed compound.*

Sampling	*Pre Fogging*		*Post Fogging*	
	Growth	*No growth*	*Growth*	*No growth*
Operation Table (n = 8)	1	7	1	7
Walls (n = 12)	2	8	0	12
Anesthesia Machine (n = 8)	3	5	3	5
Sucker Bottle (n = 6)	6	0	3	3
Patient Bed with Mattress (n = 4)	4	0	0	4
Oxygen Flow meter (n = 4)	4	0	1	3
Cardiac monitor (n = 4)	3	1	1	3
Medicine trolley (n = 2	0	2	0	2
Total	23 (47.9%)	25 (52.1%)	9 (18.7%)	39 (81.2%)

Table 3: *Bacterial counts of Air sampling before and after applying formalin fumigation and mixed comp. fogging techniques.*

Technique	*Location*	*1st Cycle*		*2nd Cycle*		*3rd Cycle*		*4th Cycle*		*p-value*
		Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	
Fogging by QUAT based compound	Recovery	1050	840	1680	1015	2205	420	805	1400	0.098
	Room 2	1015	140	735	175	175	490	210	140	
	Room 4	560	805	385	105	770	140	700	245	
Fumigation by Formalin	Room 1	840	140	350	770	420	210	350	210	0.070
	Room 3	350	105	945	315	2275	595	420	280	

DISCUSSION

Routine cleaning of the hospital rooms is not considered enough to eliminate bacteria.[14] Fumigation is performed by filling the room with toxic chemicals and sealing it for adequate time is considered effective. Fumigation using high concentration of toxic chemicals reduces microbial agents on hospital surfaces and helps in control of infections.[1] Despite of the effectiveness of this procedure we should consider the potential hazards of toxic chemicals during and after the procedure to Health care workers.[1] As we are comparing two different compounds which are used by two different techniques for checking their efficacy. Javed and his colleagues in 2008 use the same sampling technique to find microbial surveillance of operation theatres and ICUs of a tertiary care hospital.[5] A study conducted on microbial isolations from maxillofacial operation theatre and its correlation to fumigation in 2012. It was found that formaldehyde fumigation reduces cfu/m^3 of all organisms and was highly effective.[15] Their results are similar to ours in sense that formaldehyde reduces the bacterial count to approximately 3 cfu/m^3 (105) and is highly effective. Results of another study conducted in 2013 showed bacterial contamination were reduced from 70.83% to 19.44% after formaldehyde fumigation. In contrast fogging reduced the contamination from 74.3% to 13.88% which was slight greater than formaldehyde vapors.[3] In current study during fumigation by formaldehyde the number of pathogens reduces from 34.3% (n = 32) to 21.9% (n = 32) on different surfaces. On the other side after applying fogging technique a slight greater reduction from 47.9% (n = 48) to 18.7% (n = 48) was noticed on different surfaces.

We conducted this study as very sparse literature is available on this subject locally. New techniques need to be used and tested in local setups to develop national guidelines.

It is ***concluded*** that this study was that fogging by less toxic compounds takes less time and has fewer disadvantages. If we choose less toxic compounds and automatic equipment having fine particle size then potential risk to Health care workers and hospital acquired infection rate can be reduced.

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Author's Contribution

RZ: Conceived the idea of this research, conducted the research, collected all data and analyzed it. NT: Supervised the research. MSA: Helped in analysis of data collected.

REFERENCES

1. Byrns, G. and Fuller, T.P. The risk and benefit of chemical fumigation in Health care environment. JOEH. 2011; 8: 104-112.
2. Nakata, S., Ikeda, T., Nakatani, H., Sakamoto, M., Higashidutsumi, M., Honda, T., Kawayoshi, A. and Iwamura, Y. Evaluation of an automatic fogging disinfection unit. Environmental Health and preventive medicine, 2001; 6: 160-164.
3. Mishra, P.P., K, R., Verma, S. K. and Shrivastava, V. S. Comparitive efficacy of 3rd generation quaternary ammonium compounds and formaldehyde for fumigation of operation theatres. Journal of clinical and experimental research, 2013; 1: 47-53.
4. Pasquarella, C., Pitzurra, O. and Savino, A. The index of microbial air contamination. J. Hosp. Infec. 2000; 46: 241-256.
5. Javed, I., Hafeez, R., Zubair, M., Anwar, M. S., Tayyib, M. and Husnain, S. Microbial survelliance of operation theatres and ICUs of tertiary care hospital, Lahore. Biomedica, 2008;24: 99-102.
6. Singh, K., Dar, F. A. and Kishor, K. Bacterial contamination in operating Theatres of district hospital Budgam in Kashmir division. IJMHS. 2013; 3 (2): 62-63.
7. Edmud, K.K., A, M. Critical study of methods proposed to liberate formaldehyde for fumigation purposes. Am. jour. Public Health, 1998: 859-865.
8. Munro, K., Lanser, J. and Flower, R. A comparitive study of methods to validate formaldehyde decontamination of biological safety cabnets. Appl. Environ. Microbial. 1999; 65 (2): 873-876.

9. Cheney, J. and Collins, C. Formaldehyde disinfection in laboritries:limitations and hazards. British journal of biomedical science, 1195; 52 (3): 195-201.
10. Friedman, H., Volin, E. and Laumann, D. Terminal disinfection in hospital using Quaternary ammonium compounds by use of a spray – fog technique. Applied Microbiology, 1968; 16 (2): 223-227.
11. HICPAC, Rutal, W. Guidilines for Environmental infection control in Health Care. Retrieved from Centre for disease control and prevention, 2003. [online] Available at:<http://www.cdc.gov/ncidod/hip/enviro/guide.htm> [Accessed June 2014]
12. Boyce, J. M., N. L. Havill, J. A. Otter McDonald, L. C., Adams, N. T. S., Cooper, T., Thompson, A., Killgore, L. W., Tauman, A. and Wang, J.N. Impact of hydrogen peroxide vapor room decontamination on Clostridium difficile environmental contamination and transmission in a healthcare setting. Infect. Control Hosp. Epidemiology, 2008; 29 (8):723–729.
13. Qin, S., Yun, M. C. and Qi, M. Y. Aerosol spray disinfection to air and surface in wards. Chinese journal of Nosocomiology, 2006: 2003-01.
14. Clark, J., Barrett, S. P., Rogers, M. and Stapleton, R. Efficacy of super-oxidized water fogging in environment decontamination. J. Hosp. Infec. 2006; 64 (4): 386-390.
15. Bali, R., Sharma, P., Nagrth, S. and Gupta, P. Microbial isolation from maxillofacial operation theatre and its corelation to fumigation. J. Maxillofac. Oral Surg. 2012; 13: 128-132.