Frequency of Different Organism in Nosocomial Swabs using Surface Method Fumigation with Formaldehyde in Operation Theatre

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Abstract

Background: A facility within a hospital where surgical operations are carried out in a sterile environment is an operating theatre also known as an operating suite, operation theatre or operation suite. In past, the operation theatre was a place where there was an educational setting have had raised tables or chairs at the centre for performing operations surrounded by several rows of seats for students and other spectators to observe the case in progress. The objective of this research is that to better the efficacy of sterilization of operation theatre to reduce the surgical site infection and contamination at highest level.

Methodology: Data was collected from surgical department of Gulab Devi Chest Hospital. Carbolization was employed to disinfect operating room and fumigation to sterilize. After neutralization with ammonia, culture swabs were collected from OT table, OT light, OT floor, OT wall, anaesthesia machine and OT trolley. Efficacy of fumigation was concluded using statistical tools.

Results: There were no positive results prior and even after the fumigation.

Conclusion: There was no organism growth in OT. There was no evidence of Escherichia coli, Proteus Mirabilis, *Proteus vulgaris, Pseudomonas aeruginosa*, *Staphylococcus aureus*, Streptococcus spp., *E. faecalis*, Coagulase negative staph and *Salmonella choleraesius.*

Keywords: Operation theatre, fumigation, carbolization, nosocomial infection, sterilization, neutralization

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Introduction:

Sterilization is the elimination of microbiological organisms to achieve asepsis, a sterile microbial environment. An operation theatre (also known as an operating room, operating suite or operation suite) is a facility within a hospital where surgical operations are carried out in a sterile environment. Fumigation is a hazardous operation. Generally, it is a legal requirement that the operator who carries out the fumigation operation holds official certification to perform the fumigation as the chemicals used are toxic to most forms of life, including humans. A record (log book) should be kept and properly maintained for all fumigations with following details, date & time of fumigation, date & time of neutralization, personnel involved, and the dates of "sterility test visits" & their results. Construction layout plan of the surgical theatre with measurement details should be attached with the log book. The construction must have, a. Separate dressing room for medical officer and staff

nurses, b. Patient waiting room, c. Surgical room, d. Veranda. Construction, carpentry, plumbing, electrical, cleaning and other works should be completed before the initiation of fumigation procedure. Room allotted for surgery (as shown in the plan) should not be used for any other purposes. Entire block should be thoroughly cleaned before fumigation. All apparatus such as suction, table, focus lights, AC units, *etc.* should be cleaned according to manufacturer instructions. Surroundings should be clean and free from garbage, open drainage, bushes, shrubs, wastes, *etc.* Warning notice should be pasted on the front door indicating fumigation is in progress. Entry should be restricted to authorized persons only (Label must be pasted on the main door). Separate footwear should be kept at the entrance (inside) of surgical theatre (1). Theatre dress (includes head cap, mask, apron, footwear, *etc.*,) should be made available for all persons who are entering into the surgical theatre (surgeons, anaesthetists, microbiologist team, nurses, theatre assistants & helper). Surgical theatre should be cleaned and fumigated periodically depending upon the case load. (2)

Increased prevalence of nosocomial infection has seen in this advancing medical era, mostly in operation theatres and in intensive care units where the microbial contamination is high (3). With the rise in multidrug resistant *Staphylococcus Aureus* (MRSA), and other resistant strains, there is great difficulty in infection control (4). Fumigation is a very acceptable method of sterilization where high level of microbiological cleanliness is required. There are different methods of fumigation for operation theatre, for example fumigation by formaldehyde, fumigation by potassium permanganate, fumigation by per acetic acid and fumigation by quaternary ammonium compound.

The fumigation method guidelines are for each 1000 cubic feet, 500 ml of formaldehyde (40% solution) added in 1000 ml of distilled water (if not available use tap water) in an electric boiler. Switch on the boiler, leave the room and seal the door. After 45 minutes, variable depending to volume present in the boils apparatus/its heating proficiency, switch off the boiler without entering in to the room. (Switch off the main from outside) (5) The main methods which are commonly used for fumigation are Electric boiler fumigation method and bowl method. (6) Formaldehyde vapour is an extremely effective Biocidal agent. It acts as an alkylating agent, inactivating micro-organisms by reacting with carboxyl, amino, hydroxyl and sulfhydryl groups of proteins as well as amino groups of nucleic acid bases. (7) Fumigation with formaldehyde commonly used to sterilize the OT and other rooms. After sealing the windows, switch off fans and A.C. formalin is heated to generate the formaldehyde vapours. For each 1000 cubic feet of the volume of the operation theatre 500ml of formaldehyde of 40% solution added in 1000ml of water in an electric boiler. After 45 minutes switch off the boiler without entering in the room. The reaction produces considerable heat, and so heat resistant vessels should be used. When formalin vapours generated, doors should be sealed and left unopened for 48 hours. In a bowl method, five bowls are used. For each 1000 cubic feet, 500ml of formaldehyde 40% solution added in 1000 ml of distilled water

and pour this solution in to the bowls. Four bowls are placed at the corner of operating room and fifth one is placed in the centre of the operating room, then close the doors and left unopened it for 48 hours.

Before entry into the OT the next day morning, 300mL of 10% ammonia solution is kept for 2-3 hours to neutralize formalin vapours.(8) Fumigation is effective at above the temperature of 20ºC and relative humidity of 65%. (9) The rationale of this research is that to better the efficacy of sterilization of operation theatre to reduce the surgical site infection and contamination at highest level. The main aim of this study is to develop effective fumigation strategies that increase fumigation efficiency and to reduce bio-burden of operating room. Additional goals may include that to know the relationship between the air in the operating room and the surgical site infection and the factors contributing the surgical site infection such as type of surgery, duration of operation and position of patient on operating list and the in vitro disinfecting efficiency.

Material and Methods:

Study Design: This study was descriptive type.

Settings: Surgical department of Gulab Devi Chest Hospital

Duration: The duration of study was 6 months.

Sample Size: 50 operating room samples were taken for the purpose to complete this research. Sample was calculated using p=25%, d=8% using the following formula:

$$n = Z^2_{1-\alpha/2} \frac{P(1-P)}{d^2}$$

Sampling Technique: Purposive sampling technique was used to collect the data.

Inclusion criteria: Fumigated operating room after carbolization following neutralization by ammonia.

Data Collection Procedure: Data was collected from surgical department of Gulab Devi Chest Hospital. Carbolization and fumigation were performed and were neutralized with ammonia. Culture swabs from different points (OT table, OT light, OT floor, OT wall, OT trolley and anaesthesia machine). Collected swabs were streaked on nutrient agar, MacConkey agar and blood agar plates, incubated at 37°C for 24 hours and the colonies were subjected to biochemical tests for identification. Efficacy of fumigation was concluded by using statistical tools.

Statistical Analysis Procedure: The data was entered and analysed by using SPSS version 20. While the qualitative data like positive infection, positive growth and OT swab points were presented in the form of charts and tables along its percentage.

Operational definition:

Operation theatre: An operating theatre is a facility within a hospital where surgical operations are carried out in a sterile environment.

Sterilization: Sterilization is refer to any process that eliminates, removes, kills or deactivates all forms of life and other biological agents such as fungi, bacteria, viruses, spore forms, prions, unicellular eukaryotic organisms present in a specified region.

Fumigation: Fumigation is a method of pest control that completely fills an area with gaseous pesticides or fumigants to suffocate

or poison the pest within. This method is used for sterilization of operation theatre.

Sterility: A state of being free from biological contaminants.

Intensive care units: An intensive care unit also known as intensive therapy unit is a special department of hospital or health care facility that provides intensive treatment medicine.

Biocidal agent: A biocide refers to an agent that kills bacteria and mold and biological agents.

Contamination: It refers to the presence of an unwanted constituent, contaminant or impurity in a material, physical body, natural environment, workplace etc.

Instruments: An instrument is an apparatus or machine that is used in the prevention, diagnosis or treatment of illness or disease, or for detecting, measuring, restoring, correcting or modifying the structure or function of the body for some health purposes.

Nosocomial infection: A hospital acquired infection also known as a nosocomial infection that is acquired in a hospital or other health care facility.

Personal protective equipment: Specialized clothing or equipment worn by employees for protection against health and safety hazards. That is designed to protect many parts of the body, i.e., eyes, head, face, hands, feet and ears.

Neutralization: It is a chemical reaction in which acid and a base react quantitatively with each other.

Result:

Table 1, Table 2, Table 3, and **Table 4** are showing types of surgeries and types of fumigation as well as outcomes of fumigation procedures.

Discussion:

The research conducted by me, showed zero percent contamination in operation theatre before and after fumigation while in contrast to it a research was conducted in 2012, according to which total of eight bacteria genera and four fungal species were observed. The following bacterial pathogens were isolated; *Escherichia coli* (10.0%), *Proteus Mirabilis* (8.33%), *Proteus vulgaris* (6.70%), *Pseudomonas aeruginosa* (23.3%), *Staphylococcus aureus* (0.83%), *Streptococcus* spp. (18.3%), *E.faecalis* (3.33%), coagulase negative *staphylococci* (28.3%) and *Salmonella choleraesius* (0.83%). Ofloxacin and ceftriaxone showed encouraging results against the isolates. (10) In another study, coagulase negative *Staphylococci* 32.35 % were the most frequently isolated microorganism followed by *Pseudomonas aeruginosa* 23.52 %, *Acinetobacter* species 13.72 %, *Staphylococcus aureus* 11.76 %, *Klebsiella* species 9.8, *Proteus* species 5.88 % *Escherichia coli* 2.94 %. A total of 50 samples were taken from the same site (before the fumigation) at post fumigation by formaldehyde. The formaldehyde-based fumigation decreased the number of all pathogens to 19.44% were seen prior to fumigation. There is a wide difference in both of these results are due to a great variation in environment, attitude, practices and type of surgeries. This difference is due to the reason as might be in previous research they studied highly contaminated cases as compare to our study. On the other hand, formalin maybe

used formalin in lower concentration and may be they used different SOPs in operation theatre as compare to use by us.

Conclusion:

According to this study, there is 0% contamination in Operation Theatre prior to fumigation and after the fumigation process. There was no evidence of *Escherichia coli, Proteus Mirabilis, Proteus vulgaris, Pseudomonas aeruginosa, Staphylococcus aureus, Streptococcus spp., E. faecalis,* coagulase negative staphylococci and *Salmonella choleraesius.* Boiler method is better than bowl method because it requires less time for fumes formation and neutralization. After fumigation through boiler method it was always very easy to neutralize the OT.

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Table 1. Fumigation Methods

Fumigation methods	Frequency	Percent
Bowl Method	25	50.0%
Boiler Method	25	50.0%
Total	50	100%

Table 2. Type of Surgery

Type of surgery	**Frequency**
Clean Surgery	36.0%
Clean Contaminated Surgery	34.0%
Contaminated surgery	30.0%
Total	100%

Table 3. Growth before Fumigation

Growth before fumigation		
	Frequency	Percent
No	50	100.0%

Table 4. Growth after Fumigation

Growth after fumigation		
	Frequency	Percent
No	50	100.0%

Supplementary File 1:

Study Questionnaire

Hospital name:_____

Fumigation time:_____

Duration b/w two adjacent fumigations: _____ Days

Fumigation method:

Bowl method: ☐ Boiler method: ☐

Types of surgery:

Clean surgery ☐ Clean contaminated ☐ Contaminated ☐

Swab taken from:

Ot light ☐ Ot table ☐ A/C duct ☐ Wall ☐ ESU ☐

Anaesthesia machine ☐ Ot floor ☐ Air ☐ Suction machine ☐

Growth:

Pre fumigation swab:

Escherichia coli ☐ Proteus Mirabilis ☐ *Proteus vulgaris* ☐

Pseudomonas aeruginosa ☐ *E. faecalis* ☐

Staphylococcus aureus ☐ Streptococcus spp. ☐ Coagulase negative staph ☐

Salmonella choleraesius ☐

Post fumigation swab:

Escherichia coli ☐ Proteus Mirabilis ☐ *Proteus vulgaris* ☐

Pseudomonas aeruginosa ☐ *E. faecalis* ☐ *Staphylococcus aureus* ☐

Streptococcus spp. ☐ *choleraesius* ☐ *Salmonella* ☐

Coagulase negative staph ☐