

Microbiological surveillance of various sterilization parameters in ophthalmic operation theatre at a tertiary centre of south India

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Abstract

Background: Post-surgical infective endophthalmitis is a nightmare for every Ophthalmologist. It is rightly placed as the most dreaded and unpredictable complication. So, an equal importance is given to sterility of the operation theatre. The environment inside the theatre is dynamic and continuously changing. Good infrastructure does not imply safe environment as number of humans and their mobility affect it. The air and equipments inside an operating theatre may harbor a diverse array of micro-organisms. In this retrospective study we analyzed the microbiological surveillance records of our operation theatre of last 2 years from Jan 2017 to Jan 2019 for the sources of contamination, organisms we encountered and the remedial measures we took to improve efficiency of various disinfection methods, handling of instruments, testing of OT staff for carriage and amendments to the standard operating protocol (SOP) of the operation theatre staff. **Materials and Methods:** The present study was a retrospective analysis of microbiological surveillance of major Ophthalmic theatre and theatre personnel. In the major operating room, sampling was conducted 104 times over 2 years. After fumigation with formaldehyde, before the starting of the next surgical procedure, sealing of the room was done for 24 hours. Monthly assessment of Environmental Bacteria Carrying Particle (BCP) load / bio load was done by sedimentation method prior to the commencement of the surgeries. In the surgical operating room, swabs were collected from the surfaces of the representative areas. **Results:** On total 5 occasions (4.80%) theatre environment was having risk for airborne infection. (High bacterial count on 4 occasions (3.84%) and presence of *S. aureus* on 1 occasion (0.96%).) Clostridium species was not detected in any sample. AC filter was positive for fungus on one occasion and autoclave sterilization was found to be unsatisfactory on 2 occasions. Remedial measures were instituted. **Conclusion:** There is high need for the routine microbiological surveillance of Ophthalmic operating rooms to minimize the risk of development of exogenous post-surgical infections.

Key Word: Microbiological Surveillance, Sterilization Parameters, Ophthalmic theatre.

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INTRODUCTION

Innumerable number and types of micro-organisms are present in every hospital, contaminating it and making it source of infection. Hence the issue of sterilization of operation theatre deserves its due credit, ever since the conception of the principles of asepsis and sterilization which was put forward by Lister in 1866.¹ Among the patients those are undergoing surgical procedures in these operation theatres, post-surgical infection remains the leading cause of morbidity and severe vision loss in ophthalmology.^{2,3} Such infections can be either of endogenous or exogenous origin. Factors associated with contamination of hospitals and transmission of infective

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material exogenously in hospitals include, but are not limited to, use of inadequately sterilized equipment, contaminated environment and hospital staff who are infected and who continue to shed the pathogens, with the potential to infect several patients. For limiting such complications and for encouraging early wound healing, it is vital to maintain asepsis and sterile environment during any surgical procedure. It is recommended that for conventional operating theatres the amount of colony forming units (CFU) should not exceed 35 cfu/m³ in an empty theatre or 180 cfu/m³ (Approximately 10 colonies on 10 cm agar plate by sedimentation method) during an operation⁴. In comparison to developed countries like UK and USA, India has seen high incidences of such post-operative hospital induced infections, mainly due to previous prevalent practices, inadequate anti-microbial measures and tropical climate. It is imperative to maintain strict asepsis in the Ophthalmic operating room because of high risk of development of post-surgical infection including endophthalmitis.^{4,5} This is especially true in ophthalmic camps, where the incidence and frequency of occurrence of post-surgical endophthalmitis was found to be increased. With proper anti-infection protocols and more thorough sterilization practices, such post-surgical eye infections can be greatly reduced.^{6,7}

In this retrospective review we look at the microbiologic surveillance records of our Operation theatre over the last 2 years from Jan 2017 to Jan 2019, sources of contamination, organisms we encountered and the remedial measures we took to improve the efficacy of various disinfection methods, handling of instruments, testing of OT staff for carriage and amendments to the standard operating protocol (SOP) of the operation theatre staff.

AIMS and OBJECTIVES

- To evaluate the efficacy of disinfection methods used and sterilization of instruments
- To determine the main sources of contamination
- The remedial measures to improve efficiency of various disinfection methods, handling of instruments during sterilization, screening of OT staff for shedding of pathogens and amendments to the standard operating protocol of the operation theatre.

METHODOLOGY

Our study was carried out at Department of Ophthalmology with the cooperation of Department of Microbiology, Dhanalakshmi Srinivasan Medical College

and Hospital, Tamil Nadu, India. We looked at microbiological surveillance reports of Ophthalmology operation theatre where only Ophthalmologic surgeries are performed. Over a period of 2 years, sampling was conducted 104 times. Every weekend, high-level disinfection and sterilization procedure was carried out with 40% formaldehyde with addition of small amount of KMnO₄. Fumigation was repeated after an infective surgery. Before starting of next surgical procedure, sealing of the room was done for 24 hours. For neutralizing the irritational effect of the formaldehyde solution, liquid ammonia was used two to three hours prior to next surgical procedure. Currently weekly assessment of Environmental Bacteria Carrying Particle (BCP) load is being done by sedimentation method (Settle plate method), the prior practice of monthly samples was abandoned as the surgical case load is increased 10 folds during yester years. In this method, number of micro-organisms expressed as cfu/m³ and is calculated by Koch' sedimentation method²⁰

$$Cfu/m^3 = \frac{A \times 1000}{P \times T \times 0.2}$$

A= number of colonies on agar plate, P=surface area of agar plate in cm², T= Exposure time of agar plates into minutes 10cm sized Mc Konkey's agar or blood agar is been exposed to horizontal surfaces (Operating table, scrubbing room, autoclave room and other surfaces) for one hour. Agar plates were preincubated overnight so that contaminated plates can be discarded. After exposure for one hour, agar plates were incubated at 37° overnight. Next day, colonies were counted and representative colony was evaluated by colonial morphology, Gram staining and biochemical reactions. Even a single colony of *S. aureus* was considered as a risk factor for the development of infection.⁷ In the surgical operating room, swabs were collected from the surfaces of various representative areas (Operating table head end, theater door, lens cupboard door, microscope biome including eye piece, phaco machine, instrument trolley, suction machine) followed by their inoculation in Robertson's cooked meat media. Blood agar plates were further used for the inoculation of the anaerobic cultures. Swabs from air conditioner filters were analyzed for presence of fungus at 3 monthly intervals. Commercially available chemical indicator (Process indicator) strips were used for every autoclave cycle for detection of efficacy of sterilization. Swabs from nasopharyngeal area of theatre personnel were taken after written and informed consent at six monthly interval and analyzed for presence of β hemolytic streptococcus (Throat swab) and *S. aureus* (Nasal swab from anterior nasal vestibule).

RESULTS

Table 1: Results of microbiological survey BCP and surface sampling of operation theatre.

No. of samplings conducted	104
High bacterial count (more than 10 colonies per 10cm agar)	4 (3.84%)
Detection of S. Aureus	1 (0.96%)
Presence of Clostridium	Nil
Total	5 (4.80%)

Chemical indicator (Process indicator) strips were used for every autoclave cycle for detection of efficacy of sterilization. Sterilization process was found to be unsatisfactory on 2 times. Swab samples from AC filters have been analyzed 8 times and on one occasion fungus was isolated from agar plate. 20 times nasal swabs and 20 times pharyngeal swabs were evaluated for 5 theatre personnel those are working with close association with patients. One throat swab was positive for β hemolytic streptococcus and one nasal swab was positive for S. Aureus.

Remedial measures

1. Air conditioner filters were meticulously cleaned using a sporicidal solution.
2. Theatre personnel having positive nasopharyngeal swab underwent suitable treatment during which they have been advised not to work in theatre. Post treatment swabs were negative.
3. To improve efficiency of disinfection methods, Conjunctival swab for one eyed patient, Intracam cefuroxime for immune compromised cases.
4. Handling instruments – Avoid stacking instruments in autoclave.
5. All disinfectants were checked for contamination.
6. Staff to refrain from using washrooms in between cases.

DISCUSSION

Post-operative infections are directly affected by the layout of the operating room, instrument sterilization and sterilization protocol followed for disinfecting the operating rooms. The most critical evaluation is required for theatre disinfection and instrument sterilization procedures. It is of utmost need for periodic and timely microbiological assessment of the working areas of the operation theatre in which surgery has to be performed. A positive relation has been observed between the aerobic bacterial count and risk of development of infection. The microbiological load of theatre air is one of the important parameters for surgical site infection. As calculated by Lidwell OM¹⁹ a surgery lasting for one hour will have

270/cm² bacteria carrying particles falling into the wound. The risk of infection depends on the viability, virulence of bacteria, surgical site involved and host defense. Hence, we evaluated microbiological surveillance reports for the efficiency of various disinfection methods for theatre and instrument sterilization in our institute where Ophthalmic surgeries were carried out. In the present study, we observed a high Bacteria Carrying Particle (BCP) load along with presence of S. aureus in the operative room in approximately 4.80% of the occasions. No laminar air system was present in the room. In the Ophthalmic operation theatres, it is advised to use the laminar air flow system although it is not documented properly by authorities. An efficiency of more than 95 percent has been observed when air passes through 5 μ m filter which increases to 99.97% when it crosses through HEPA filter (High efficiency particulate air filter which cleans 0.3 μ m particles). The benefits of laminar air flow system other than Orthopedic surgery is been evaluated for developing guidelines under Centers for disease control and prevention.¹⁵ There was no record available about number of people entering the theatre. Apart from nasopharyngeal shedding, microscopic skin fragments are being shredded by staff in theatre which was contaminated by the bacteriological colonies of individual's skin. All individuals have different dispersion level, but overall shredding increased by increase in number of people entering the theatre and their movements.¹⁶ White AB *et al*⁹ compiled the data on sterilization of operating rooms and proposed that for the reduction in the microbial agents on the surfaces of the theatres, fumigation has been required with high concentrations of toxic chemicals. Chemical fumigation has been used for "building decontamination" after bioterrorism activities, in agriculture and in residential complexes. Incidents have been reported where chemical fumigation have caused illness and even death. Full knowledge of side-effects and benefits along with advantages is necessary before using biological hazardous technologies especially among vulnerable individuals and health care workers. They also reviewed the efficiency of fumigation method by inactivating the external surfaces of the environmental objects and reducing the infection rate of the patients. Dharan S *et al.*¹¹ reviewed the data on the post-operative complications occurring in patients due to infections arising from surgical site infection agents. It is still a topic of controversy that whether airborne bacteriological agents cause infectious processes in the health care workers and surgeons or not. Particles size of equal to or more than 5 microns is removed by the filtration system which is routinely employed by the modern surgical rooms. Brynes *et al*¹⁰ in their study tried to do a microbiologic profiling of organisms found inside the Ophthalmic operation theatre. They outlined the

environmental bacteriological profile, sterilization system and protocol followed in their theatre over a period of 21 months. They mainly showed staphylococcus and beta-hemolytic streptococci in such infections. They found that in more than 5 percent of the occasions, there was a significant increased risk of airborne infections. They concluded that there is a significant need for the standardization of sterilization protocols in all operating theatres. Bryne G and Dharan S *et al*^{10, 11} in another study assessed the contamination of patients in post-surgical phase by the fungal micro-organisms. From the results, they concluded that in the reduction of the fungal spores, quality and design of air conditioning unit plays an important role. Guidelines for design and construction of Hospitals and health care facilities¹⁷ recommended desired theatre temperature between 20-30°C, relative humidity between 30-60%, minimum 15 times air change per hour with air movement from clean to less clean area. Kelkar *et al*.¹² recommended monthly use of biological indicators for monitoring sterilization process, weekly BCP load monitoring, assessment of presence of Clostridium spores over theatre surfaces to ensure cleanliness, six monthly evaluation of nasal and throat swab of theatre staff for carrier of Staph. Aureus or β hemolytic streptococci and 3 monthly evaluation of air conditioner filters for fungal growth. Krogulski A *et al*¹³ studied the efficiency of air conditioning systems in reducing the microbial contamination of the operation theatre. They concluded that the efficiency of the air conditioning unit has a direct correlation with the lower microbial contamination level of the operation theatres. Friling E *et al*¹⁴ analyzed factors which predispose patients to develop endophthalmitis after undergoing cataract surgery. The results showed that risk factors such as pre-existing endogenous infection and poor hygiene were associated with an increase in rates of endophthalmitis.

LIMITATIONS

1. No record available to count the people entered in theatre.
2. There are no standardized method and its frequency available for air sampling in operation theatres. There is no consensus between sedimentation method (Settle plate method) versus volumetric air sampling.⁵ Though settle plate method is a crude way for analyzing air quality but it does provide a simple and cost-effective way to assess air quality over multiple horizontal surfaces.
3. Correlation between findings and postoperative infections could not be established directly as remedial measures have been taken.

CONCLUSION

We conclude that there is a high need for regular microbiological surveillance of Ophthalmic operating theatres, continual audits and amendments to protocol at every center to ensure the highest degree of patient safety. Continued educational program for theatre staff should be emphasized.

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