International Journal of Infection Control
www.ijic.info ISSN 1996-9783

ORIGINAL ARTICLE

How effective are face masks in operation theatre? A time frame analysis and recommendations

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doi: 10.3396/ijic.v9i1.003.13

Abstract

This study was conducted to check the efficacy of face masks in limiting bacterial dispersal when worn continuously in Operation Theater. A comparison was done to find out difference between fabric and two ply disposable masks. The first sample was collected prior to wearing the mask, using cough plate method holding a blood agar plate approximately 10 -12 centimeters away from the mouth. The personnel were asked to produce "ahh" phonation. Participants were then asked to don the face mask, continue routine work and report to the study center located inside the theater for further sample collections at designated intervals of 30, 60, 90, 120 and 150 minutes after wearing the fabric mask made of cotton. The study was replicated on immediate next day using two ply disposable mask keeping all the other conditions and personnel exactly the same. Bacterial counts before wearing the mask were 5.36±4.38 and 5.7±2.99 on day 1 and day 2 of study. Bacterial counts were 0.96±1.06 (P<0.001) and 0.7±0.87 (P<0.001) at 30 min; 2.33±1.42 (P<0.001) and 2.36±1.03 (P<0.001) at 60 min; 3.23±1.54 (P=0.007) and 4.16±1.78 (P=0.011) at 90 min; 5.63±4.02 (P=0.67) and 4.9±1.98 (P=0.161) at 120 min and 7.03±4.45 (P=0.019) and 5.6±2.21 (P=0.951) at 150min respectively for fabric and two ply disposable mask. Counts were near pre-wear level in about two hours irrespective of the type of mask. There was no significant difference between cotton fabric and two ply disposable masks. Face masks significantly decreased bacterial dispersal initially but became almost ineffective after two hours of use.

Key words

Masks and microbiology; Cross infection and prevention and control; Bacterial load; Disposable equipment; textiles

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Introduction

Face masks are important components of surgical attire. Effective face mask acts as a protective shield for the wearer. Face masks protect the personnel from inhaling any potentially hazardous infective particle from entering the oral or nasal space. Face masks also prevent bacteria from dispersing in the vicinity of the operative site from the surgeon's oro-pharynx or naso-pharynx, which are one of the most microbial infested parts of the human body. This study was conducted to check the efficacy of face masks in limiting bacterial dispersal when worn continuously in operation theatre. A comparison was done to find out difference between fabric and two ply disposable masks.

Background

Post operative infections are important component of the spectrum of nosocomial infections. In-spite of excellent surgical techniques, in the field of ophthalmic surgery the major infective complication of concern is postoperative bacterial endophthalmitis. Post surgical infections in ophthalmic practice are often attributed to contamination from the conjunctival and lid margin flora, from contaminated surgical intraocular instruments, or occasionally from infective organisms getting inoculated into the eye during the procedures.[1,2,3]

In surgical practice the surgeons and the operating team wear special attire before entering the theatre complex and don it till they complete their work schedule. Face masks are important components of this attire as the oral and nasal cavity are one of the most microbial infested parts of the human body. Face masks prevent bacteria from dispersing in the vicinity of the operative site from the surgeon's oro-pharynx or naso-pharynx which may be linked to risk of infective complication. Effective face mask also acts as a protective shield for the wearer. Mikulicz is accredited with advocating the use of face masks way back in 1897.[4] Alwitry *et al*. conducted a study to determine the need for use of surgical facemasks during cataract surgery. Bacterial load in the vicinity of the operative fields were evaluated when the surgeons wore face masks and when they did not. The study showed that the bacterial dispersal was indeed increased when the surgeons were operating without wearing the surgical face masks. The authors concluded that in view of the serious consequences of the complication of post operative endophthalmitis it is necessary to wear surgical face mask during cataract surgery.[5]

Face masks worn during operative procedures in India are either of fabric (usually of cotton) which are reused after cleaning and autoclaving. Disposable face masks are also in use. These are made up of synthetic material (single ply /two ply/three ply) which are to be disposed after a single use. Face masks prevent the microbes normally colonising the respiratory passage of the wearer to be dispersed in the environment and also protect the wearer from pathogens in the environment. In routine practice, face masks are worn while entering the operation theatre complex and are worn throughout the period of operations to be discarded while leaving the theatre which may be even up to eight hours of usage.

Our study aimed to find out the bacterial filtration efficacy of face masks when worn continuously in operation theatres and to establish a relationship between time and contamination of face masks. Another objective was to compare the two ply disposable face masks and fabric (cotton) face masks in above mentioned settings.

Methods

This study was conducted in an ophthalmic multi-specialty hospital conducting different types of eye surgeries. All theatre staff included in the study (n=30) were provided with cotton face mask one per each user in the morning prior to entry to the theatre complex. The fabric mask used was of 200 GSM (grams per square meter) type of cotton cloth.

Prior to wearing the mask personnel was sampled by a cough plate method holding a blood agar plate approximately 10-12 centimetres away from the mouth. The personnel were asked to produce "ahh" phonation. The subject was then asked to don the face mask and continue his routine work and report to the study centre for further sample collections at designated intervals. The sample collection centre was located inside the theatre itself. Samples were collected at following intervals:

First Sample: without mask

Second Sample: at thirty minutes

Third Sample: at one hour
Fourth Sample: at one hour thirty minutes
Fifth Sample: at two hours
Sixth Sample: at two hours thirty minutes

The sampling was repeated each time in the same way as the first sample taking precaution that the mask is worn continuously during the work inside the theatre complex and for collection of sample as well.

The observations were replicated next day wherein the same personnel were asked to wear a "Two – ply" disposable face mask. (n=30).

The blood agar plates were incubated at 37ºC for 24 hours and colony count was performed.

Exclusion criteria:

1. Theatre personnel having complaints suggestive of active respiratory tract infection and
2. Those who gave a treatment history of broad spectrum antibiotic over last seven days were not included in the study.

Results

Thirty theatre personnel including surgeons participated in the study. With fabric face masks the blood agar settle plates showed evidence of growth of organisms comparable to the first sample without mask at two hours and the counts were more than the first sample after two and half hours. Table I and figure 1 depicts that cotton fabric face masks are effective for filtration

Table I. Colony counts after wearing fabric masks

Time	Average no. of bacteria (Mean ± SD)	p-value
Without Mask	5.36 ± 4.38	
After 30 min	0.96 ± 1.06	< 0.001
After 1hr	2.33 ± 1.42	< 0.001
After 1.30 hr	3.23 ± 1.54	0.007
After 2hr	5.63 ± 4.02	0.67
After 2.30 hr	7.03 ± 4.45	0.019

Figure 1. Average bacterial count plotted against time of wearing the fabric face mask

Table II. Colony counts after wearing "Two – ply" disposable face masks

Time	Average no. of bacteria (Mean ± SD)	p-value
Without Mask	5.7 ± 2.99	
After 30 min	0.7 ± 0.87	<0.001
After 1hr	2.36 ± 1.03	<0.001
After 1.30 hr	4.16 ± 1.78	0.011
After 2hr	4.9 ± 1.98	0.161
After 2.30 hr	5.6 ± 2.21	0.951

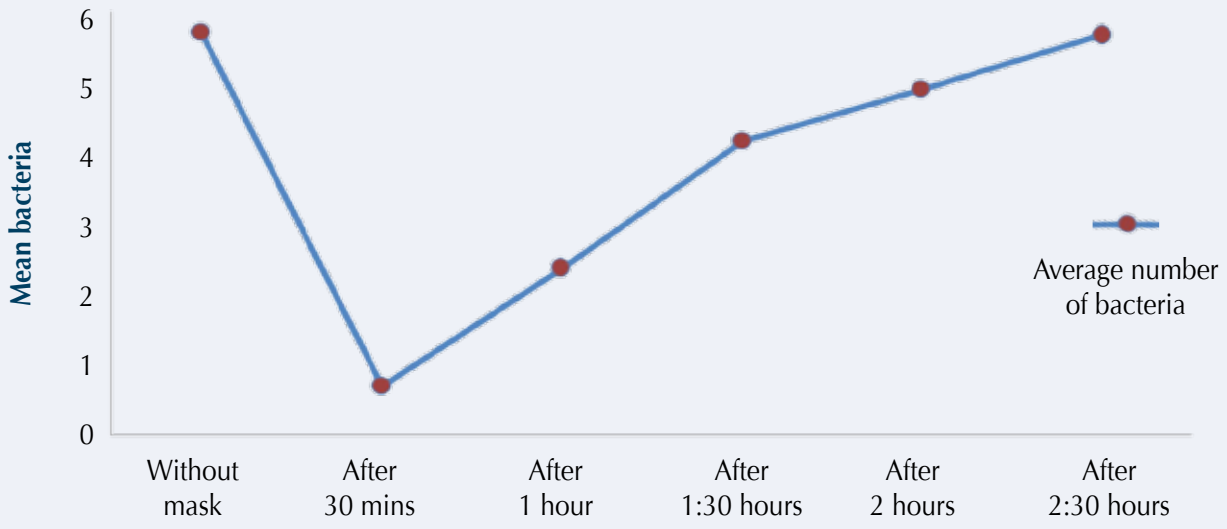

Figure 2. Average bacterial count plotted against time of wearing the disposable "Two – ply" mask

of bacteria for first 90 minutes gradually losing utility in about 2 hrs time frame. Table II and figure 2 depicts that disposable face masks are effective for filtration of bacteria for first 90-120 minutes after which they gradually loosing utility. The two ply disposable masks had the counts increased to pre-wear levels by two hours and thirty minutes.

Table III depicts the comparative bacterial counts prior to wearing of the face masks and at subsequent time intervals. It was found that the effectiveness of the fabric mask was slightly better at 90 mins, but the disposable mask was more effective after two hours. But there was no significant difference earlier and later. Both types of masks were rendered ineffective by two and half hours.

Discussion

That facemasks should be worn when the operator is in close proximity to the sterile field has been proven on earlier studies.[6, 7] We observe from the present study that surgical face mask cause a significant reduction in the bacterial dispersal. "Two – ply" disposable face masks seem to be slightly better option when compared with cotton face masks for use in operation theatre complexes. Cotton face masks if used must be washed after every use and sterilized unlike two ply disposable masks which can be binned. Both need to be changed after use of two hours so as to ensure effective filtration of bacteria.

Table III. Comparision of fabric and disposable "Two - ply" masks.

Time	Mean ± SD		p-value
	Fabric Mask	Disposable mask	
Without Mask	5.36 ± 4.38	5.7 ± 2.99	0.732
After 30 min	0.96 ± 1.06	0.7 ± 0.87	0.295
After 1hr	2.33 ± 1.42	2.36 ± 1.03	0.918
After 1.30 hr	3.23 ± 1.54	4.16 ± 1.78	0.03
After 2hr	5.63 ± 4.02	4.9 ± 1.98	0.376
After 2.30 hr	7.03 ± 4.45	5.6 ± 2.21	0.14

These are the results from a dedicated ophthalmology operation theatre. But these results are valid for any operating room where the surgeon operates for long hours like neurosurgery, joint replacement surgery or oncosurgery. Wherever the surgeon operates more than 2-3 hours at a stretch, he/she should change their face mask every 2 hours, ideally every 90 minutes. Even in high volume ophthalmic surgery, in which the surgeon performs multiple procedures, he/she should change their masks every 90-120 minutes.

Nosocomial infection and operation theatre induced infections are a major cause of poor outcome after surgery. Simple check lists have been shown to reduce surgical errors. Similarly introduction of simple measure of regularly changing face masks at fixed time intervals depending upon the type of face masks used would help reduce the chances of air borne dispersal of organisms and subsequent infections.

There have been numerous studies indicating that the use of face masks has some effect on surgical wound infections.[8-11] Unfortunately, the evidence in the literature has often been conflicting and with little definitive guidance offered. Operating masks were shown to have a significant effect on the number of bacterial organisms falling to the operative site. There were significantly fewer organisms cultured when the surgeon used a facemask (p=0.0006).[5]

There is a paucity of information in the literature offering definitive evidence with regard to the practice of surgical facemask utilisation for the prevention of postoperative infective complications. The necessity for routine use of surgical facemasks during interventional procedures has been questioned.[9,10] The majority of the clinical research carried out to date on the topic focus specifically on general surgical and gynaecological procedures.

Philips *et al.* [6] examined the bacterial contamination at a distance of 30 cm from a subject's mouth when a mask was or was not utilised. Organisms grown were upper respiratory tract commensals including coagulase negative staphylococci and α - haemolytic streptococci. The unmasked group showed a statistically significant increase in surface bacterial growth. They concluded that facemasks should be worn when the operator is in close proximity to the sterile field. McLure and colleagues [7] confirmed this finding in a similar study; however, when Tunevall and Jorbeck [8] looked at the effect of mask use on the number of bacterial CFUs in the vicinity of thyroid operations, they found no significant statistical difference between the study groups.

The exact pathogenesis of endophthalmitis after different ophthalmic surgeries is not very clear. The source of the bacterial inoculums required to cause the infection and the method of pathogen intraocular access has not been fully identified. Potential sources of bacterial contamination are from the conjunctival and lid margin flora, from contaminated surgical intraocular instruments, or from infective organisms falling onto the eye during the procedure.[1,2,3]

In the present study we have demonstrated that the use of a surgical facemask during ophthalmic surgery leads to a statistically significant reduction in the number of bacterial organisms falling on to the

operative site ($p<0.001$). The study helps to establish that in developing countries, where resources could be a constraint for providing disposable face masks, the fabric face masks can also be used equally effectively if changed frequently ideally at around 90 minutes. In larger corporate hospitals where financial resources is not a handicap the two ply disposable face masks need to be replaced after every two hours of continuous use.

Acknowledgements:

Ms Snehal Homkar for helping with culture media.

References

3. Liesegang TJ. Use of antimicrobials to prevent postoperative infection in patients with cataracts. *Curr Opin Ophthalmol* 2001; **12:** 68–74. http://dx.doi.org/10.1097/00055735-200102000-00012
4. Mino de Kaspar H, Grasbon T, Kampik A. Automated surgical equipment requires routine disinfection of vacuum control manifold to prevent post-operative endophthalmitis. *Ophthalmology* 2000; **107:** 685–690. http://dx.doi.org/10.1016/S0161-6420(99)00178-5
5. Walker CB, Claoue CM. Incidence of conjunctival colonisation by bacteria capable of causing post-operative endophthalmitis. *J R Soc Med* 1986; **79:** 520–521.
6. Mikulicz J. Das Operieren in strerilisierten Zwirnhandschuhen und mit Mundbinde. *Centralblatt fur Chirurgie* 1897; **26:** 714.
7. Alwitry, E Jackson, H Chen, R Holden. The use of surgical facemasks during cataract surgery: is it necessary? *British J Ophthalmology* 2002; **86:** 975–977. http://dx.doi.org/10.1136/bjo.86.9.975
8. Phillips BJ, Fergusson S, Armstrong P, *et al*. Surgical face masks are effective in reducing bacterial contamination from the upper airway. *Br J Anaesth* 1992; **69:** 407–408. http://dx.doi.org/10.1093/bja/69.4.407
9. McLure HA, Talboys CA, Yentis SM, *et al*. Surgical face masks and downward dispersal of bacteria. *Anaesthesia* 1998; **53:** 624–626. http://dx.doi.org/10.1046/j.1365-2044.1998.435-az0528.x
10. Tunevall TG. Post-operative wound infection and surgical face masks: A controlled study. *World J Surg* 1991; **15:** 383–386. http://dx.doi.org/10.1007/BF01658736
11. Skinner MW, Sutton BA. Do anaesthetists need to wear surgical face masks in the operating theatre? A literature review with evidence-based recommendations. *Anaesth Intens Care* 2001; **29:** 331–338.
12. Romney MG. Surgical face masks in the operating theatre: re-examining the evidence. *J Hosp Infect* 2001; **47:** 251–256. http://dx.doi.org/10.1053/jhin.2000.0912
13. Tunevall TG, Jorbeck H. Influence of wearing masks on the density of airbourne bacteria in the vicinity of the surgical wound. *Eur J Surg* 1992; **158:** 263–266.