

Original Research Article

An assessment of the benefit of surgical face masks in preventing aerosol droplet spread during a simulated spinal anaesthetic-a blinded in vitro study.

Abstract

Aims :- The purpose of this study was to assess the benefit of wearing a surgical face mask in reducing aerosol contamination of agar plates in a simulated spinal anaesthetic. The contamination of plates with virulent organisms, association of growth with recent upper respiratory tract infection and food intake were also studied.

Method :- A poster containing written text was fixed to a wall, with a standard agar plate suspended at its midpoint. Each volunteer (n=30) then read the text from the wall chart to simulate verbal interaction with a patient during a spinal anaesthetic, initially wearing a surgical mask and then once again without a mask.

Results :- This study revealed an increased risk ($p = 0.006$) of bacterial growth on agar plates when not wearing a surgical face mask. Results also suggest that eating prior to surgical procedures may increase the risk of contamination of the surgical field in the absence of a barrier mask.

Key words

Facemasks, Oral commensals, Meningitis

Introduction

Although rare, infectious complications from regional anaesthesia can be devastating. Incidence rates for infectious complications vary substantially between studies, ranging from 3.7 to 7.2/100,000 for spinal anaesthesia-associated meningitis and from 0.2 to 83/100,000 for epidural anaesthesia-associated epidural abscesses¹. Various strains of α haemolytic streptococci have been reported as causative organisms of post lumbar puncture meningitis^{2,3,4}. These strains are normal nasopharyngeal and oral commensals with very low virulence but once exposed to the cerebrospinal fluid they multiply rapidly to full blown meningitis within days⁵.

28 Although current recommended practice is to wear a surgical face mask when performing
29 central neuraxial blockade to prevent infective complications⁶, little evidence exists that
30 wearing a face mask reduces the incidence of post lumbar puncture meningitis.
31 The purpose of this study was to assess whether wearing a surgical face mask in a simulated spinal
32 anaesthetic environment, reduced aerosol contamination of microbiological agar plates. Oral microbial
33 flora can change significantly with upper respiratory tract infection (URTI) and also with recent food
34 intake, this association was studied as a secondary end point.

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36 **Methods**

37 With Institutional ethical approval thirty healthy volunteers were enrolled from our theatre
38 department staff. All recruits were clinical health care workers experienced in applying and
39 wearing barrier face masks (3 ply disposable face masks, *OPTIPRO*, Shanghai, China). All
40 volunteers were informed about the purpose of the study and written consent was obtained
41 before inclusion. No specific exclusion criteria were considered.

42 A printed poster (size A3) containing written text was fixed to a wall in a vacant cleaned
43 theatre with an air flow exchange of twenty times per hour. A centre blank portion was
44 removed, into which a standard agar plate was fixed with adhesive tape. Volunteers were
45 asked to sit on a height adjustable stool with their mouths level with the centre of the agar plate. The
46 stool was a fixed distance of 30 cm from the wall chart and plate.

47 Each volunteer then read the text from the wall chart “out loud” to simulate verbal
48 interaction with a patient during a neuraxial block. Initially the volunteer performed the study
49 wearing a mask (control) and then repeated the performance without wearing a mask (study). Each
50 was asked to read at a steady rate and asked to repeat until fifteen minutes elapsed for
51 each performance. Agar plates were changed (wearing sterile gloves each time) between
52 performances and masks were applied after each volunteer had washed their hands in a sterile
53 fashion (five minute surgical scrub using chlorhexidine hand wash). Plates when removed were
54 labelled using a random number system and the examining microbiologists were blinded to control
55 and study groupings.

56 Columbia blood agar plates were used for the study. The agar plates were incubated in 5%
57 CO₂ (rest aerobic) environment for 48 hours at a temperature of 35 C – 37 C. The plates

58 were examined for the presence of colony forming units and these results were recorded. The
 59 organisms present were identified using standard microbiological identification techniques as
 60 employed on a daily basis in the clinical laboratory for the identification of such organisms
 61 from clinical and environmental samples.

62 Prior to the study volunteers were questioned as to whether they had consumed food in the preceding
 63 thirty minutes and the presence of symptoms of an URTI within two weeks of that date.

64 During the performance of the study the theatre environment was maintained constant with
 65 the volunteer present solely with a single investigator. The investigator wore a surgical mask
 66 which was changed at fifteen minute intervals and stood at a distance of twenty feet from the plates
 67 during the study. A neutral agar plate was hung on a separate wall in the theatre throughout the study
 68 performance and was changed every four hours. Four such plates were created during the study and
 69 also went in a blinded fashion for culture.

70 A group of 30 subjects was required for a power of eighty to achieve a significance of
 71 $p < 0.05$. Mann Whitney's test was performed between all groups to see whether the differences were
 72 significant and an ANOVA test was performed to adjust for possible confounders. For more than 2
 73 groups the Kruskal-Wallis test was used

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75 Results

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77 A total of 64 agar plates were cultured in a blinded fashion by the investigating microbiology
 78 service, 30 study, 30 control and 4 ambient air neutral plates. No volunteers or plates were
 79 excluded and subjects were comparable between groups for age and gender, (table 1). The blinding
 80 process and numbering of plates led to data being analysed as independent groups.

81 Table 1. - Characteristics of study volunteers, n= number.

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83	Total volunteers	N =30
	Male: Female	56.67% (N=17) : 43.33% (N=13)
84	Age :-	
	Median male age	35
	Interquartile range	9
85	Median female age	37
	Interquartile range	12
86	Doctors	56.67% (N=17)
	Nurses	26.66% (N=8)
87	Allied Health Care Professionals	16.66% (N=5)

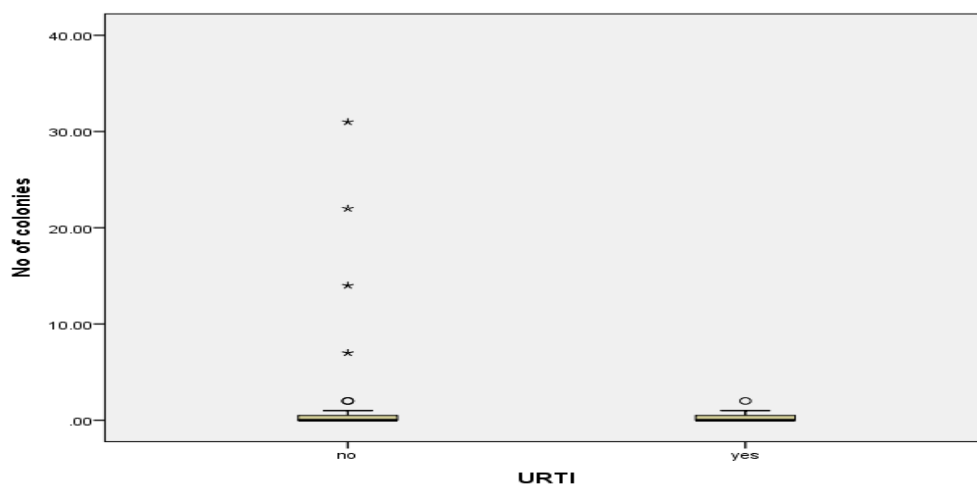
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Alpha haemolytic Streptococci	18.51% (N=5)
Commensal Neisseria Species	11.11% (N=3)
Bacillus species (not B. Cereus)	7.40% (N=2)
Others	22.22% (N= 6)
Corynebacterium Species (diphtheroids)	14.81% (N=4)

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119 No multi-drug-resistant bacteria were cultured. The numbers of colony growths were analysed
 120 comparing recent infection to bacterial growth with a higher number of colonies in the group with no
 121 recent URTIs, but with no demonstrable difference between groups when the Mann Whitney U Test
 122 was applied,($p=0.966$), (figure 2).

123 **Figure 2** :- Box Plot demonstrating colony forming unit growth in both study groups based on recent
 124 upper respiratory tract infection (yes) or (no) recent infection



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126 When the number of colonies was tested between food intake groups, growths were greater in the
 127 recent food intake group which was demonstrated to be almost significant by the Mann Whitney U test
 128 ($p=0.082$), median with mask = 0, IQR(0,0) and median without mask = 0, IQR(0,1), figure 3.

129 **Figure 3** :- Box Plot demonstrating colony forming unit growth in both study groups based on recent
 130 food intake (yes) or not (no).

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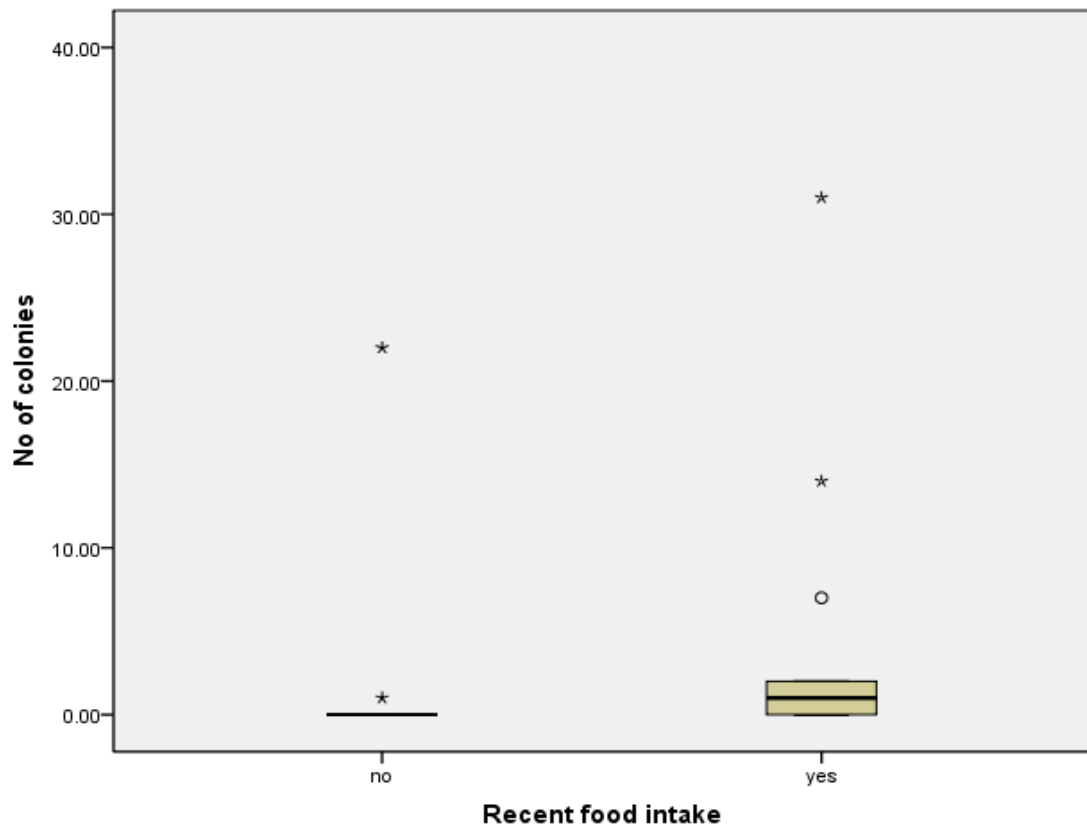
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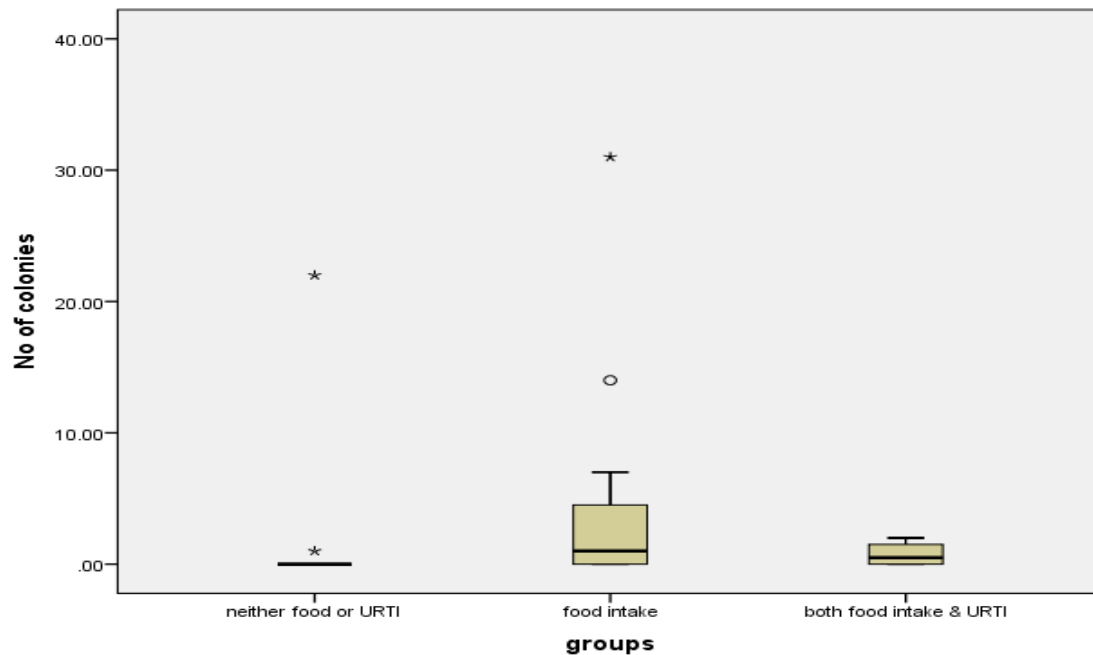
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Exploratory analyses were carried out using ANOVAs to test whether the number of colony forming units was significantly different between facemask groups, while adjusting for recent URTIs and food intake. When adjusted the difference between the facemask groups became non-significant suggesting these were confounding factors.

Subgroup analysis of participants further separated into groups where they did or did not have an URTI and/or food revealed differences between groups. Applying the Kruskal-Wallis test to the without facemask group when the number of colony forming units were tested the differences were significant ($p=0.037$). Subjects with food intake tend to have higher numbers of colonies,(figure 4). Median number for group with neither URTI or food intake = 0, IQR (0,0), Median for food intake only group = 1, IQR(0, 5.75). Median for group with both URTI and food intake = 0.5, IQR(0, 1,75).

Figure 4 :- Box Plot: Subgroup analysis of subjects not wearing facemasks and growth of colony forming unit



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165 There was no growth on the four neutral agar plates exposed to the surrounding air, suggesting no
166 effect on the results secondary to environmental contamination.

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168 Discussion

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170 In this study, bacterial growth on blood agar plates was significantly greater in the group not wearing
171 surgical facemasks when performing a simulated neuraxial block. The presence of bacterial growth
172 was higher when face masks were not worn. This data suggests that the wearing of masks should
173 reduce the risk of infection to patients by preventing droplet contamination of the sterile field. Of
174 significant importance was that all colonised bacteria were deemed to be “non-pathogenic” with the
175 majority of cultured bacteria being coagulase negative staphylococci (CoNS). While not a common
176 cause of meningitis, CoNS in one study was the causative bacteria in 11% of cases of adult
177 meningitis⁷. In all cases a disrupted barrier of the central nervous system was present which would be
178 in keeping with the situation present during a neuraxial block.

179 The ecological conditions within the mouth are dependent on a number of variables with
180 transient fluctuations influenced by both frequency and type of food ingested⁸. In addition
181 recent food intake may influence quantity and thus microbiological consistency of saliva

182 potentially increasing the quantity of droplet spread and dispersion during surgical
183 procedures. We demonstrated a potentially significant trend towards increased bacterial
184 colonisation in the subjects tested within thirty minutes of recent food ingestion. The type of
185 food ingested was not noted but the results suggest that eating prior to surgical procedures
186 may increase the risk of contamination of the surgical field in the absence of a barrier mask.
187 It is well documented that during speech or coughing that the mouth can expel a number of
188 different sized droplets to the surrounding environment as an aerosol. Interestingly in our
189 group studied, presence of an URTI in the preceding two weeks did not influence increased
190 bacterial spread.

191 In this study while every effort was made to simulate the conditions of a neuraxial block, it
192 was not identical to a real anaesthetist- patient encounter. Particularly the method selected
193 with volunteers speaking continuously while in proximity to the agar plates might not be the
194 practice of all anaesthetists. Many anaesthetists may not speak during such a procedure, both
195 reducing the spread of droplets and also keeping the face mask drier and maintaining a more
196 effective barrier for a longer period. In addition while the data relating to recent food intake
197 and recent URTI may suggest a causal effect on increased bacterial growth, it should be noted
198 the study was powered for mask/non- mask wearing and bacterial growth alone.

199 Our study supports previous evidence in this area⁵, which recommend the wearing of face
200 masks by personnel involved in the practice of accessing the spinal meninges by injection.

201 While the virulence of the bacteria demonstrated in this study was low with no multi-resistant
202 species transferred to the “patient” surface, this risk could be reduced even further if medical
203 personnel performing such injections wear a simple barrier face mask.

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205 Ethical Approval – Ethical approval was issued by the chair person , Ethical Committee Board,
206 University Of Limerick.

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208 **References**

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