SHORT REPORT

Effect of surgical mask position on bacterial contamination of the operative field

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Summary: The influence of surgical mask usage on bacterial contamination of the operative field was studied during 30 cardiac catheterization procedures. Mask position was varied during each procedure according to a predesigned random table. The number of bacterial colonies recoverable when no mask was worn was significantly higher than that detected when a full mask was worn (P < 0.002). Shedding of Staphylococcus epidermidis was greater when no mask was worn (mean 5.2 colonies 10 min⁻¹) than shedding with full mask (mean 2.7 colonies 10 min⁻¹; P < 0.004). Although mask placement below the nose was associated with higher mean colony counts than that above the nose, these differences were not statistically significant.

Keywords: surgical mask; surgical wound infection.

Introduction

Since its initial use by a German surgeon in 1897,¹ the surgical mask has been repeatedly modified, scrutinized and criticized.² Most studies of mask effectiveness have involved in-vitro challenge with bacterial inocula and aerosols, or analysis of postoperative infection rates.

As of 1992, no guidelines were in effect regarding the use of surgical masks by our cardiac catheterization laboratory. When employed in this and other operative areas of the hospital, surgical masks are often placed below the nose, at the discretion of the physician. A study was instituted to determine the relationship between mask usage and bacterial shedding during cardiac catheterization.

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Materials and methods

All procedures were performed in a single sterile theatre which is used solely for cardiac catheterization. A single group of individuals participated throughout the study, and entered the room in a clean set of disposable gown, cap and surgical mask. Individual catheterization procedures were performed in rotation by one of seven senior cardiologists through a percutaneous femoral artery puncture with strict aseptic technique.

Bacteriological samples were obtained by exposing an encoded sheep blood agar plate with sterile external surfaces (Hy Laboratories, Israel), within the draped operative site, adjacent to the femoral puncture wound. Each experiment involved exposure of a separate plate for 10 min, following placement or removal of the surgical mask by an assistant. In order to reduce the influence of procedure length on bacterial shedding, masks were removed or positioned above and below the nose according to a pre-written schedule. Thus, any given experiment could begin with no mask, progressing to either full or subnasal mask; or there could be any other combination or order. During the course of the study, the order of mask placement would also vary several times for each participating physician. Participants were encouraged to speak and otherwise behave in their accustomed manner.

A single lot of disposable sterile paper masks (2-Delta-P, Tecnol, Inc) was used throughout the study. A single nasal swab from the physician was immediately plated on sheep blood agar after every experiment. All bacterial colonies were enumerated and identified by a ‘blinded’ technician, using standard technique.

Following completion of 30 experiments, a number of sampling plates were noted to have heavy growth (15–20 colonies), and a decision was made to break the study code. When a relatively high bacterial count was found to be associated with non-usage of masks the study was discontinued in the interest of patient safety. No postoperative infections were encountered during the study.

Statistical analyses employed the Student’s paired t-test and McNemar and Wilcoxon signed rank tests as appropriate.

Results

Bacterial colonies were demonstrable following virtually all stages in the study, regardless of mask placement (Table I). The number of colonies recoverable when no mask was worn was, however, higher than that detected when a full mask was worn ($P<0.002$). Similarly, shedding of *Staphylococcus epidermidis* was significantly greater when no mask was worn (mean 5.2 colonies 10 min$^{-1}$), than shedding with full mask (mean 2.7 colonies 10 min$^{-1}$, $<0.004$; Student’s paired t-test and Wilcoxon signed rank test).

There was no statistical relationship between the order of mask placement
Surgical mask position and contamination

Table 1. Effect of mask position on bacterial contamination of the surgical field following 30 catheterization procedures

<table>
<thead>
<tr>
<th>Culture result</th>
<th>No mask</th>
<th>Mask below nose</th>
<th>Full mask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive culture (%)</td>
<td>96.7</td>
<td>90.0</td>
<td>86.7</td>
</tr>
<tr>
<td>Mean colony count ± SD</td>
<td>6.4 ± 4.6</td>
<td>4.0 ± 3.3</td>
<td>3.2 ± 2.8</td>
</tr>
</tbody>
</table>

\[ P^* \]

\[
\frac{0.02/0.04}{<0.002/<0.002}
\]

\[ \text{Staphylococcus epidermidis} \%
93.3 80.0 76.7
\]

\[
\text{Mean colony count ± SD}
5.2 ± 4.0 3.6 ± 3.2 2.7 ± 2.7
\]

\[ P^* \]

\[
\frac{\text{NS/NS}}{<0.004/<0.007}
\]

*Student's t-test/Wilcoxon signed rank test; ns, not statistically significant.

and colony count or species recovered. Similarly, data did not vary when plate exposure to individual physicians was analysed. Although no overt correlation was demonstrable between the species recoverable from concurrent plate and physician cultures, Gram-negative bacterial species were identified in four nasal cultures (Moraxella osloensis, Citrobacter diversus, Serratia plymuthica and Citrobacter freundii); while a corresponding organism (Moraxella osloensis) appeared in only one plate culture, obtained when a surgical mask was worn below the nose. Similarly, a single plate culture positive for Streptococcus pyogenes had been exposed while the corresponding mask was placed below the nose. The recovery of other species (α-haemolytic streptococci, diphtheroids, Bacillus spp.) could not be correlated with mask position or physician flora.

There was no significant difference in recovery of Staphylococcus aureus, when usage of full mask and no mask were compared (five plates and seven plates positive respectively). Similarly, the presence or absence of S. aureus in nasal culture did not correlate with its recovery on exposed agar plates \( P>0.05 \), McNemar test.

Discussion

In a recent study, the incidence of wound infection following laparotomy, herniorrhaphy, thyroid and other forms of major surgery was not affected by the use of face masks. Others have shown that factors such as entry of personnel into the operating theatre or placement of the mask within an overlapping hood were more important determinants than the presence of a
Cardiac catheterization, the subject of the present investigation, carries little if any risk of wound infection. None of 2883 such procedures recently reviewed resulted in local or systemic infection.\(^4,5\)

Our data suggests that bacterial shedding on to the operative field is significantly higher when no mask (as compared to full mask) is worn; however, a relationship between contaminant density and wound infection rate has not been established. Although the bacterial species isolated (staphylococci, enterobacteriaceae) were assumed to represent contamination from personnel, the exact anatomical source for these organisms is unclear. In any given case, bacteria may have originated from the mouth, nose, hair or skin surface; and species other than \textit{S. aureus} may have little clinical significance in this setting.

Our data present a contrast to a recent study which failed to demonstrate contamination of agar plates placed one metre from unmasked subjects under operating room conditions.\(^7\) Failure to demonstrate a significant difference between full- and subnasal-mask placement may represent a \(\beta\)-error (insufficient sample size), resulting from discontinuance of the study for safety reasons. We would encourage additional study of the effect of surgical masks on bacterial shedding and postoperative wound infection.

References


