Air suctioning during colon biopsy acquisition reduces bacterial contamination

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Abstract

Background and Aim: Contamination of endoscopy suites with bacteria during procedures is of concern particularly through droplets during handling of biopsy specimens. It has been advocated that suctioning while removing the biopsy forceps could help to reduce potentially hazardous bioaerosols. The aim of the present study was to evaluate the efficacy of air suctioning during removal of the biopsy forceps.

Materials and Methods: Airborne bacteria were collected by an impactor air-sampler (MAS-100). Fifty liters of air were collected continuously for 30 seconds at a 30 cm distance from the colonoscope suction channel. Room air samples were taken in the endoscopy suite in the morning prior to the beginning of the endoscopy program, during colonoscopy with a sham biopsy in the descending colon with and without suctioning and at the end of the procedure day. Standard 90 mm Petri dishes containing a selective medium for gram-positive cocci (CNA blood agar) were used with the impaction sampler and colony forming units/m3 (cfu) were determined. Results: Measurements were performed at fifty consecutive colonoscopies. Prior to the beginning of the endoscopy program, the bioaerosol burden in the colonoscopy suite reached a mean of 4.2 cfu/m3. During colonoscopies performed without suctioning at biopsy the bioaerosol burden increased to 29.4 cfu/m3 whereas this burden increased only to 15.1 cfu/m3 when the suctioning was applied during removal of the biopsy forceps. The difference in bioaerosol burden between suctioning and no suctioning was highly significant (p < 0.0005). At the end of the procedure day the airborne bacteria count dropped to 15.6 cfu/m3. The analysis of the colonies on the CNA blood agar identified predominantly enterococci. Staphylococci spp. and other gram-positive bacteria were rarely isolated. Conclusion: The present study indicates that the bioaerosol burden during handling of biopsy specimens is not neglectable but can be reduced by the simple habit of applying suctioning during acquisition of biopsies. This practice might be an important infection-control measure during gastrointestinal endoscopies.
Air Suctioning During Colon Biopsy Acquisition Reduces Bacterial Contamination

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Keywords

- air biocontamination
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- air succioning
- bioaerosols

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Abstract (Word count 245)

Background and Aim: Contamination of endoscopy suites with bacteria during procedures is of concern. It has been advocated that suctioning while removing biopsy forceps could help to reduce hazardous bioaerosols. The aim of the present study was to evaluate the efficacy of air suctioning during removal of biopsy forceps.

Materials and Methods: During colonoscopy endoscopists were asked to remove the biopsy forceps with and without suction after having touched the sigmoid mucosa. Fifty litres of air were collected continuously for 30 seconds at 30 cm distance from the colonoscope suction channel. Airborne bacteria were collected by an impactor air-sampler (MAS-100). Standard 90 mm Petri dishes with CNA blood agar were used to culture gram positive cocci. Room measurements prior to the first endoscopy and after the last endoscopy of the day were used as controls.

Results: Measurements were performed during 50 colonoscopies. At the beginning and at the end of the endoscopy program the bioaerosol burden were 4.2 ± 1.8 cfu/m³ and 15.6 ± 2.5 cfu/m³ respectively. Applying suction during removal of the biopsy forceps reduced the bioaerosol burden from 29.4 ± 4.6 cfu/m³ to 15.1 ± 2.7 cfu/m³ (p<0.001). The analysis of the colonies on the CNA blood agar identified predominantly enterococci.

Conclusion: The present study indicates that the bioaerosol burden during handling of biopsy specimens is not neglectable and can be reduced by the simple habit of applying suctioning when removing biopsy forceps. This practice might be an important infection-control measure during gastrointestinal endoscopies.
Introduction

The colon is populated with a diverse community of microorganisms whose quantity make up more than half of the wet weight of faeces. Human stool is reported to contain as many as $10^{11}$-10$^{12}$ colony forming units (cfu)/g of faeces (1,2). Large bowel preparation for colonoscopy focused primarily on cleansing most faeces out of the colon. Still, many bacteria are left behind and colonoscopes have been found to harbour as many as $5.2 \times 10^5$ cfu/ml after clinical use (3). Bacterial burden of endoscopes after proper cleaning, high-level disinfecting, and rinsing have been studied extensively (4-10). On the other hand, the magnitude of air contamination of endoscopic suites during and after gastrointestinal endoscopic procedures is under-investigated as are strategies to reduce the spraying of faecal bacteria into the air. Lessons learned from air contamination during bronchoscopic procedures cannot be readily applied to endoscopic procedures since (1) pulmonary airborne pathogens pose different risks to examiners and supporting staff compared to colonic pathogens and (2) diagnostic and therapeutic procedures differ during bronchoscopy and lower GI endoscopy.

Among the instrumentation procedures, insertion and removal of forceps through the biopsy channel of the endoscope are considered important factors in interpatient instruments-related infection (11). These procedures may also be an important factor to spread colonic bacteria into the air leading to bacterial contamination of the endoscopy suites. To measure the extent of hazardous working conditions and air pollution different sampling devices have been investigated. At least 10 air samplers are currently marketed, and are based on different physical principles (mainly impaction, centrifugal acceleration or filtration). Impactors are the most widely used type of sampler in the hospital setting (12,13). In this study we chose the MAS-100 impactor air sampler, which has been used for some time.

With this background we designed a study aimed at measuring bacterial air contamination before, during and at the end of an endoscopy day by an impactor air sampler and to evaluate a simple strategy of applying suction during biopsy forceps removal to reduce air contamination during endoscopy.
Methods

The present study was performed in the Endoscopy Unit and approved by the Ethics Committee of the University Hospital of Zurich as part of a Quality Control Program. Over a 4-months period air samples were collected during elective, diagnostic colonoscopies performed in one endoscopy suite in our institution. Air samples were not collected during emergency colonoscopy as were procedures involving therapeutic interventions (i.e. polypectomy, hemostasis, stent insertion). Patient data were limited to age, gender, indication for colonoscopy, date and time of colonoscopy and colon preparation method. Before starting the study, all endoscopists from our unit attended a procedure briefing provided by the principal investigator (SRV), in order to standardize air sample collection and instrumentation suction (see below). Premedication varied according to the preference of the individual endoscopist but consisted mostly of propofol 60-400mg or combination of midazolam 2.5-5mg and/or meperidine 25-50mg intravenously. Examinations were performed in left lateral decubitus or supine position.

Collection of air samples. To quantify biological hazardous working conditions and air pollution various air sampling devices can be used. Commercially available air samplers use different physical principles (impaction, centrifugal acceleration or filtration) to collect and quantify bacterial air colonisation. In hospital settings impactors are the most widely used type of sampler (12,13). At our institution the “MAS-100” (MBV, Littau, Switzerland) impaction sampler is used to collect in hospital bioaerosols (Figure 1a and b) given the ease of use and local expertise with this device. Over a 2-week period background air samples were collected in the early morning prior to the first endoscopy. During each colonoscopy scheduled in one suite the endoscopist was asked to insert a biopsy forceps through the biopsy channel and touch the mucosa of the sigmoid and/or descending colon. The endoscopist then removed the biopsy forceps without applying suction during instrument removal. Air samples of 50 litres were collected over a period of 30 seconds during removal. Then the endoscopist was asked to repeat the same procedure, this time while applying suction during instrument removal. Air samples were also collected at the end of the endoscopy program.
Quantification of air contamination and microorganism identification. Standard 90 mm Petri dishes containing a selective medium for gram-positive cocci (CNA blood agar; Columbia agar, Oxoid, Basingstoke, UK) were used with the impaction sampler and colony forming units (cfu)/m³ were determined. After air sampling, the CNA blood agar plates were incubated aerobically at 35°C for 3 days using standard procedures. Microrganisms were identified using API (bioMerieux, St. Louis, Mo). Testing was performed according to manufacturers’ instructions. Microbial identification data on the recovered micro-organisms from pilot cases (data not shown) indicated that 99% of the bacteria recovered from the air samples were gram-negative bacilli commonly associated with the intestinal tract (Escherichia coli and Bacteroides). These gram-negative bacteria formed colony-forming units (cfu’s) on culture plates too numerous to count. Therefore, in order to avoid a ceiling effect of measurements, we decided to use a gram-positive selection media (CNA blood agar) to quantify air contamination.

Statistics. Statistical calculations were done using InStat version 3.05 (GraphPad, San Diego, CA). Continuous parameters are reported as median ± SD or SEM as indicated and proportions as percentages. A p-value of < 0.05 was considered statistically significant.
Results

Between January 2005 and May 2005 air samples during 50 colonoscopies were collected. *Patient demographic data:* 27 endoscopies were performed in males and 23 in females. Median age was 56.4 ± 16 years (range 21-85) (Table 1), indication for colonoscopy and colon cleansing procedure used are detailed in table 1. In 41 patients macrogol (Fordtran Streuli®, Streuli Pharma, Switzerland) and in 9 patients monobasic sodium phosphate and dibasic sodium phosphate (Colophos®, Spirig, Switzerland) were used for bowel preparation. The most commonly indication for colonoscopy was abdominal pain (40%) followed by screening colonoscopy (38%), stool irregularities (32%), hematochezia or melena (20%), iron deficiency anemia (18%), weight loss (6%) and anal pain (2%).

**Quantifying bacterial air burden**

In preliminary studies microbial identification of the recovered microorganisms indicated that 99% of the bacteria recovered from the air samples were gram-negative bacilli commonly associated with the intestinal tract *(Escherichia coli and Bacteroides)* (data not shown). These gram-negative bacteria formed colony-forming units (cfu’s) on culture plates too numerous to count. Therefore, in order to get more consistent measurements, only a gram-positive selection media (CNA blood agar) was used. The analysis of the colonies on the CNA blood agar identified predominantly enterococci. *Staphylococci* spp. and other gram-positive bacteria were rarely isolated.

Figure 2 summarizes the results of 50 consecutive patients. Measurements were performed at fifty colonoscopies. Prior to the beginning of the endoscopy program, the average (± SEM) bioaerosol burden of the colonoscopy suite was 4.2 ± 1.8 cfu/m³. When the forceps was removed without applying suction the airborne micrororganisms load increased to 29.4 ± 4.6 cfu/m³. When suction was applied during forceps removal the bacterial aerosol burden increased only to 15.1 ± 2.7 cfu/m³ when the suctioning was applied during removal of the biopsy forceps. The difference in bioaerosol burden between suctioning and non-suctioning was highly significant (p<0.0005). At the end of the procedure day the airborne bacteria count was 15.6 ±
2.5 cfu/m³ still, significantly higher (p<0.001) than at the beginning of the procedure day (Figure 2).

Bioaerosol burden increased with the time of day at which colonoscopy was performed. Still, bioaerosol burden when removing the biopsy forceps under suctioning was always lower compared to situations when the biopsy forceps was removed without suctioning (Figure 3). By the following morning the airborne microorganism load returned to “baseline” and no accumulation effect was noted.

**Isolated bacteria species**

As mentioned in the method section selecting only gram positive bacteria was deliberately chosen in order to avoid ceiling effects during quantification. The analysis of the colonies on the CNA blood agar identified predominantly enterococci. Staphylococci spp. and other gram-positive bacteria were rarely isolated.
Discussion

In the present study we report bacterial air burden in the endoscopy suite before, during and after colonoscopies. Applying simple measures such as applying suction during forceps removal reduces bacterial contamination in the surrounding air, limiting the biohazard to which examiners, supporting staff and patients are exposed. Among methods aimed at reducing bacterial spread air suctioning during forceps removal is a simple and inexpensive method to reduce air contamination. It requires primarily the endoscopist’s awareness of the effects of pushing the suction button on the endoscope for a short period of time when handling is focused on forceps removal. To our surprise we didn’t find in the literature any previous reports on the burden of bioaerosols and infections among health care professionals working in gastrointestinal endoscopy suites.

Colonoscopes are used in an area of the body with high numbers of microrganisms. To perform colonoscopies presents a special bacterial challenge to the decontamination of endoscopes and endoscopy units because the colon has a large and diverse microbial population. Microorganisms present in the colon such as Pseudomonas, Helicobacter pylori, Salmonella, Hepatitis B and C, and others have been hold responsible for endoscopy-related infections (14-17). Another interesting question is whether endoscopy could be responsible for in-hospital spread of Norwalk-virus gastroenteritis. Since the present study focused primarily of detection of bacteria the question of virus-related infections can’t be addressed directly. Still, given the increased amount of germs dispersed in the air it’s conceivable that aerosols could play an important role in the transmission of highly infectious enteric viruses.

Gram-negative rods account for approximately 99% of the bioburden within the suction channel after use and after cleaning (Chu 1998). Gram-positive bacteria are the primary isolates from the colonoscope surface (Chu 1998) both after use and after cleaning. Because gram-posive cocci and diphteroids are part of the normal microbiota of the skin, these bacteria may have been introduced by the hospital environment or by handling. While these bacteria may be of negligible importance for immune-competent patient patients, they could become relevant in immune-
suppressed patients. Until this has been clarified we consider that simple measures as air suctioning during forceps removal should be encouraged to minimize this risk.

In the present study we could show, that the bioaerosol burden during handling of biopsy specimens is not neglectable and can be reduced by the simple habit of applying suction when removing biopsy forceps. The limitation of the present study is that we only reveal a reduction of the bioaerosol burden without showing the clinical relevance of such a practice. A number of studies maintain the concept that endoscopic procedures don’t place patients at any increased risk of infection and that infection is an infrequent complication of endoscopy (18-22). It was probably this concept of extreme rare infections following colonoscopies which decreased the enthusiasm of systematically evaluating the impact of aerosol burden in the endoscopy suites. Of note is that these studies examined only transmission of microorganisms by endoscopes without analyzing the room air contamination during endoscopies.

The conclusion of the present study is as simple as the tested hypothesis: since air-suction during biopsy acquisition decreases bioaerosol load in the endoscopy suite this simple intervention should be included among the infection-control measures during gastrointestinal endoscopies.
Air sampling: The “MAS-100” impaction sampler is applied for the collection of bioaerosols.
The sampled air is aspirated through a perforated sieve plate onto an agar plate. The aspiration results in impaction of particles from the airstream onto the surface of agar medium. The Air then passes through an air flow meter that constantly adjusts the flow rate to the preferred volume/minute.
Figure 2: Bioaerosol load (CFU/mm3) in the endoscopy suite before the first and after the last endoscopy and after biopsy forceps was removed without and with suction.
Figure 3: Bioaerosol load when biopsy forceps was removed under suctioning and no suctioning relative to the time of the day when the colonoscopy was performed.
### Table 1 Subject Demographics: 50 consecutive colonoscopies

<table>
<thead>
<tr>
<th>Age (mean years) ± SD (range)</th>
<th>56.4 ± 16</th>
<th>(21-85)</th>
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<tbody>
<tr>
<td>Gender (M/F)</td>
<td>27/23</td>
<td></td>
</tr>
<tr>
<td>Colonoscopy preparation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macrogol</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Monobasic sodium phosphate and</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Dibasic sodium phosphate</td>
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</table>

**Indication for colonoscopy**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Count</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Abdominal pain</td>
<td>20</td>
<td>40%</td>
</tr>
<tr>
<td>Screening colonoscopy</td>
<td>19</td>
<td>38%</td>
</tr>
<tr>
<td>Stool irregularities, diarrhea, constipation</td>
<td>16</td>
<td>32%</td>
</tr>
<tr>
<td>Hematochezia, melena</td>
<td>10</td>
<td>20%</td>
</tr>
<tr>
<td>Iron deficiency anemia</td>
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<td>18%</td>
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<tr>
<td>Weight loss</td>
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<tr>
<td>Anal pain</td>
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</tbody>
</table>
ACKNOWLEDGMENT
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References


STUDY HIGHLIGHTS

What Is Current Knowledge

- Contamination of endoscopy suites during and after gastrointestinal endoscopic procedures is under-investigated
- Few strategies are known to reduce the spraying of fecal bacteria into the air especially during biopsy taking.

What Is New Here

- There is a considerable bioaerosol burden when handling biopsy specimens during colonoscopies
- This burden can easily be reduced by applying suctioning when removing biopsy forceps
- This practice might be an important infection-control measurement during gastrointestinal endoscopies