ORIGINAL ARTICLE

Microbial Load in Septic and Aseptic Procedure Rooms

Results From a Prospective, Comparative Observational Study

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SUMMARY

Background: Highly effective measures to prevent surgical wound infections have been established over the last two decades. We studied whether the strict separation of septic and aseptic procedure rooms is still necessary.

Methods: In an exploratory, prospective observational study, the microbial concentration in an operating room without a room ventilating system (RVS) was analyzed during 16 septic and 14 aseptic operations with the aid of an air sampler (50 cm and 1 m from the operative field) and sedimentation plates (1 m from the operative field, and contact culture on the walls). The means and standard deviations of the microbial loads were compared with the aid of GEE models (generalized estimation equations).

Results: In the comparison of septic and aseptic operations, no relevant differences were found with respect to the overall microbial concentration in the room air (401.7 ± 176.3 versus 388.2 ± 178.3 CFU/m³; $p = 0.692$ [CFU, colony-forming units]) or sedimentation 1 m from the operative field (45.3 ± 22.0 versus 48.7 ± 18.5 CFU/m²/min; $p = 0.603$) and on the walls (35.7 ± 43.7 versus 29.0 ± 49.4 CFU/m²/min; $p = 0.685$). The only relevant differences between the microbial spectra associated with the two types of procedure were a small amount of sedimentation of *Escherichia coli* and *Enterococcus faecalis* in septic operations, and of *staphylococcus aureus* and *pseudomonas stutzeri* in aseptic operations, up to 30 minutes after the end of the procedure.

Conclusion: These data do not suggest that septic and aseptic procedure rooms need to be separated. In interpreting the findings, one should recall that the study was not planned as an equivalence or non-inferiority study. Wherever patient safety is concerned, high-level safety concepts should only be demoted to lower levels if new and convincing evidence becomes available.

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Germany's Accident Insurance Provider for Hospitals (*Unfallversicherungsträger für Krankenhäuser*) continues to demand that aseptic (non-contaminated or clean contaminated) and septic (contaminated or dirty) surgical procedures be performed in separate locations (1). The recommendation published by the Commission for Hospital Hygiene and Infection Prevention (KRINKO, *Kommission für Krankenhaushygiene und Infektionsprävention*) of the Robert Koch Institute in 2000, “Surgical Standards” (*Anforderungen bei Operationen*), divides surgeries by contamination level but does not indicate any possible constructional or organizational consequences of doing so (2). The KRINKO's 2007 recommendation on preventing surgical wound infections also makes no mention of the subject of aseptic versus septic procedures (3).

Thanks to technical advances in recent decades, surgical procedure rooms are now almost all fitted with ventilation systems that to a great extent remove pathogens from the operative field (4).

In addition, various effective prevention measures are taken in everyday clinical practice to reduce the incidence of surgical wound infections (5–8). These include the following:

- Preoperative skin antisepsis using alcohol-based preparations that contain a prolonged-action antiseptic ingredient such as chlorhexidine or octenidine and can be applied using mechanical assistance (9, 10).
- No hair removal, or clipping instead of shaving if hair removal is required (11).
- Using two pairs of gloves or changing gloves during surgery (6, 7).
- Appropriate perioperative antibiotic prophylaxis (12, 13).
- Intraoperative normothermia (14, 15).
- Establishing interdisciplinary bundles of measures (8, 16).
- Minimally invasive surgery.
- Hygiene measures implemented within surgical procedure rooms after each procedure.

The changes in surgery conditions call into question whether the requirement for septic and aseptic

Schematic representation of surgical procedure room and layout of sampling locations for measurement of microbial load of procedure room air (N1, N2, F1, F2) and microbial sedimentation in procedure room (S1, S2) and on walls (A). Window at bottom of picture, entrance on right; O: Patient, head towards anesthesia area; X: Sampling locations (N1, N2, F1, F2) to determine air colony counts; S: Sedimentation plates (S1, S2); A: Sedimentation plates on surfaces of walls

procedures to be performed in different locations, and for different procedure types to be separated in time by following a set order for surgeries, is still necessary where appropriate ventilation is available and contact transmission via objects or staff members can be ruled out (17–20). This study therefore aimed to investigate, as a worst-case scenario, microbial levels in a surgical procedure room with no ventilation system during both septic and aseptic procedures with no spatial separation or control over the order in which procedures were performed.

Method

A prospective, comparative observational study investigated microbial levels in the air of the procedure room and microbial sedimentation for 16 septic and 14 aseptic procedures within general and visceral surgery (all performed in the same procedure room). Because the study was exploratory in nature, case numbers were not formally calculated in advance. As the study was observational and involved no clinical intervention, the ethical approval of the Ethics Committee of the University of Greifswald was not considered necessary.

For each surgical procedure, surgery type and duration and the number of people present were recorded.

The procedure room contained no ventilation system that might affect the outcome parameters. Staff were not informed of the aim of the study. The procedures performed were as follows:

- Eleven aseptic hepatic, pancreatic, and intestinal procedures.
- Three open inguinal hernias.
- Six septic procedures for perforations, ileus, and gallbladder empyema.
- Five jet lavages for massive skin and soft tissue infections.
- Three laparotomies for anastomotic failure, with and without abscesses.
- Two procedures on infected fistulae in Crohn's disease.

This range of procedures can be considered typical for visceral surgery.

Measurement of microbial load of procedure room air

The microbial load of the air in the procedure room was determined using an air sampler (IDEAL 3P, bioMérieux SA, Marcy l'Etoile, France) and agar plates (Columbia agar with 5% sheep blood, diameter 90 mm). According to the information provided by the manufacturer, this sampler measures particles of between 3 and 10 μm and detects 100% of particles measuring 5 μm or more. For each sample, 250 L of air was taken in over a period of 2.5 minutes. A new, sterile measuring head was used for each procedure. The number of colony-forming units (CFUs) detected was calculated using the correction table for the air sampler head used. Air was sampled at 2 locations near to the operating field (N1 and N2, each 50 cm from the operating table) and 2 locations further away (F1 and F2, each 150 cm from the operating table) (Figure). After the procedure room had been prepared (surfaces disinfected, instrument tables brought in) the baseline number of colonies at each sampling location was determined. This was repeated at the following times:

- At the beginning of each procedure (incision).
- Every 30 minutes during procedures.
- At the end of each procedure (closure).
- Thirty minutes after the end of each procedure.

Air colony counts (CFU/ m^3) at all sampling times and locations were evaluated. This yielded different case numbers according to the duration of the procedure in question.

Recording microbial sedimentation

Sedimentation was investigated for the duration of each procedure (incision to closure) using agar plates at sampling locations S1 and S2 (each 100 cm from the operating field, at the same height as the operating table) (Figure). To evaluate the extent of sedimentation (CFU count), the mean of the findings from the two sampling locations was recorded and the number of CFU/ m^2 /minute was calculated in order to take into account differences in procedure duration.

TABLE 1

Quantitative findings for septic versus aseptic procedures

	Septic Mean ± SD	Aseptic Mean ± SD	p-value ^{*1}
Microbial load of procedure room air			
Total CFU/m ³ *2 Range n	401.7 ± 176.3 (60 to 1496) 276	388.2 ± 178.3 (80 to 1312) 460	p = 0.692
N1/2, CFU/m ³ *2 Range n	393.5 ± 157.7 (84 to 912) 140	405.1 ± 184.7 (92 to 1060) 230	p = 0.805
F1/2, CFU/m ³ *2 Range n	410.2 ± 193.7 (60 to 1496) 137	371.3 ± 170.3 (80 to 1312) 230	p = 0.308
Start of procedure (incision), CFU/m ³ *3 Range n	392.4 ± 242.39 (108 to 1496) 64	356.1 ± 162.7 (120 to 832) 56	p = 0.547
At 30 minutes, CFU/m ³ *3 Range n	406.3 ± 135.0 (144 to 684) 36	344.2 ± 165.5 (108 to 756) 56	p = 0.272
End of procedure (closure), CFU/m ³ *3 Range n	390.2 ± 152.3 (84 to 924) 59	413.4 ± 182.5 (116 to 900) 56	p = 0.686
30 minutes after closure, CFU/m ³ *3 Range n	367.5 ± 157.8 (60 to 720) 56	420.4 ± 197.4 (136 to 1060) 56	p = 0.383
Microbial sedimentation			
S1/2, CFU/m ² /min Range n	45.3 ± 22.0 (6 to 91) 32	48.7 ± 18.5 (19 to 79) 28	p = 0.603
Contact culture			
Procedure room wall, start of procedure (incision), CFU/m ² /min Range n	24.3 ± 34.4 (0 to 118) 16	11.2 ± 16.4 (0 to 59) 14	p = 0.159
Procedure room wall, end of procedure (closure), CFU/m ² /min Range n	35.7 ± 43.7 (0 to 154) 16	29.0 ± 49.4 (0 to 177) 14	p = 0.685

Evaluation shows no significant differences in microbial load of procedure room air or in microbial sedimentation between septic and aseptic procedures.
CFU: Colony-forming unit; N1/2: Sampling locations 0.5 m from operating field; F1/2: Sampling locations 1.5 m from operating field; S1/2: Sampling locations 1 m from operating field; SD: Standard deviation

*1 p-value for effect of procedure type (septic versus aseptic) in GEE (generalized estimating equation) model

*2 Time from incision to 30 minutes after closure

*3 Mean of 4 measurement points

The microbial load of the procedure room walls was determined on 3 wall surfaces using contact culture plates (Medco contact culture plates mini with sheep blood agar, 55 mm diameter, Medco Diagnostika GmbH, Munich, Germany) (Figure). The contact culture was put in place before the first procedure performed on each day of sampling and at the beginning (incision) and end (closure) of each procedure. Findings are stated in CFU/m²/minute, comparing incision versus closure.

Statistical evaluation

Means and standard deviations of the relevant microbial load parameters were calculated for each of the 2

groups. In order to take account of the unusual structure of the data (multiple samples per procedure), statistical comparison of the 2 groups (septic and aseptic) was performed using GEE (generalized estimating equation) models for continuous outcome parameters in the form of linear regression, assuming normally-distributed residuals and link identity (21). The “exchangeable”-option was chosen as the correlation structure. Whether variables were normally distributed was determined by visual inspection of frequency distributions. Only colony counts obtained using contact cultures showed significant deviation from normal distribution. For these, GEE analyses

TABLE 2

Quantitative findings for septic versus aseptic procedures

	Septic		Aseptic		t-test
Microbial load of procedure room air (no. of measurements: septic procedures $n = 280$; aseptic procedures $n = 461$)					
Pathogen	Percentage	Mean $\pm$ SD (range), CFU/m ³ /min	Percentage	Mean $\pm$ SD (range), CFU/m ³ /min	p -value
Coagulase-negative staphylococci (CNS)	43	49.8 $\pm$ 36.69 (0 to 403)	58	39.0 $\pm$ 19.0 (0 to 191)	0.31
<i>Micrococcus luteus</i>	22	30.5 $\pm$ 26.4 (0 to 169)	15	14.9 $\pm$ 15.32 (0 to 89)	0.057
Aerobic spore-forming bacteria	27	34.5 $\pm$ 30.11 (0 to 175)	9	8.6 $\pm$ 8.32 (0 to 50)	0.004*
Molds	2	3.1 $\pm$ 4.31 (0 to 24)	2	1.1 $\pm$ 0.72 (0 to 11)	0.08
<i>Streptococcus spp.</i>	6	8.3 $\pm$ 7.71 (0 to 46)	16	10.0 $\pm$ 6.36 (0 to 46)	0.51
Viridans streptococci	<1	0.3 $\pm$ 0.58 (0 to 6)	<1	0.1 $\pm$ 0.13 (0 to 4)	0.21
<i>Proteus mirabilis</i>	<1	<0.1	0	0	to
<i>Escherichia coli</i>	<1	<0.1	0	0	to
<i>Enterococcus faecalis</i>	<1	<0.1	0	0	to
<i>Staphylococcus aureus</i>	0	0	<1	<0.1	to
<i>Pseudomonas stutzeri</i>	0	0	<1	<0.1	to
Microbial sedimentation at S1/2 (no. of measurements: septic procedures $n = 32$, aseptic procedures $n = 28$)					
Pathogen	Percentage	Mean $\pm$ SD (range), CFU/m ³ /min	Percentage	Mean $\pm$ SD (range), CFU/m ³ /min	p -value
Coagulase-negative staphylococci (CNS)	64	28.97 $\pm$ 16.66 (0 to 63)	71	32.32 $\pm$ 17.99 (3 to 63)	0.58
<i>Micrococcus luteus</i>	7	3.18 $\pm$ 4.12 (0 to 16)	4	2.00 $\pm$ 2.54 (0 to 8)	0.49
Aerobic spore-forming bacteria	22	9.97 $\pm$ 12.58 (0 to 42)	11	7.76 $\pm$ 9.25 (0 to 36)	0.52
Molds	3	1.17 $\pm$ 2.19 (0 to 8)	<1	0.17 $\pm$ 0.54 (0 to 2)	to
<i>Streptococcus spp.</i>	4	1.78 $\pm$ 4.41 (0 to 19)	14	8.41 $\pm$ 5.44 (0 to 19)	to
Viridans streptococci	0	<0.1	<1	0.10 $\pm$ 0.46 (0 to 2)	to
<i>Escherichia coli</i>	0	0.21 $\pm$ 1.24 (0 to 7)	0	0	to
<i>P. mirabilis</i> , <i>E. faecalis</i> , <i>S. aureus</i> , <i>P. stutzeri</i>	0	0	0	0	to

Evaluation shows that coagulase-negative staphylococci (CNS), *M. luteus*, and aerobic spore-forming bacteria are the most common pathogens. *E. coli*, *P. mirabilis*, and *E. faecalis* were found in septic procedures only; *S. aureus* and *P. stutzeri* were found in aseptic procedures only. No multiresistant bacteria were found. More aerobic spore-forming bacteria were released in septic procedures than aseptic procedures.

*Significant

CFU: Colony-forming unit; SD: Standard deviation; S1/2: Sampling locations 1 m from operating field

TABLE 3

Surgical procedures and microbiologically significant evidence of pathogens

Septic		Aseptic	
Procedure/indication	Pathogen	Procedure/indication	Pathogen
Excision of infected fistula (Crohn's disease)	–	Exploration for ileostomy reversal	–
Exploration of GI tract perforation	<i>E. faecalis</i>	Open herniotomy for inguinal hernia	–
Excision and/or jet lavage of soft tissue infection	–	Exploration of postoperative bleeding	–
Excision and/or jet lavage of soft tissue infection	–	Exploration of GI tract tumor	–
Excision and/or jet lavage of soft tissue infection	–	Exploration of GI tract tumor	–
Excision and/or jet lavage of soft tissue infection	<i>P. mirabilis</i> <i>E. coli</i>	Exploration of pancreatic tumor	–
Exploration of anastomotic failure	–	Exploration of pancreatic tumor	–
Exploration of infected fistula (Crohn's disease)	–	Open herniotomy for inguinal hernia	–
Exploration of perforated ileus	–	Exploration of pancreatic tumor	–
Excision and/or jet lavage of soft tissue infection	<i>P. mirabilis</i> <i>E. coli</i>	Exploration of hepatic tumor	–
Exploration of anastomotic failure	–	Exploration of hepatic tumor	–
Cholecystectomy of gallbladder empyema	–	Exploration of pancreatic tumor	<i>S. aureus</i>
Excision and/or jet lavage of soft tissue infection	–	Exploration of GI tract and hepatic tumor	<i>P. stutzeri</i>
Exploration of GI tract perforation	<i>E. faecalis</i>	Exploration of hepatic tumor	–
Excision and/or jet lavage of soft tissue infection	–		
Exploration of anastomotic failure	–		

E. coli: Escherichia coli; *E. faecalis*: Enterococcus faecalis; GI: Gastrointestinal; *P. mirabilis*: Proteus mirabilis; *P. stutzeri*: Pseudomonas stutzeri; *S. aureus*: Staphylococcus aureus

were replicated using nonparametric tests (Mann-Whitney U-test, no adjustment for data clustering). Analyses were performed using IBM SPSS Statistics, version 22, with a significance level of 0.05 (2-tailed). Because the study was exploratory, no adjustment was performed for multiple tests.

Results

Surgery duration (time from incision to closure) was 70 ± 72.9 minutes for septic procedures ($n = 16$) and 189 ± 10.2 minutes for aseptic procedures ($n = 14$) ($p < 0.001$). There was no significant difference in the mean number of persons involved in surgery (7.6 ± 2.1 for septic procedures, 8.1 ± 1.4 for aseptic procedures; $p = 0.44$).

Microbial load of procedure room air

Quantitative analysis: The baseline microbial load of the air in the procedure room was 98.7 ± 63.96 CFU/m³. There was no statistical evidence of differences between the two groups. This was true for both microbial load throughout surgery up to closure (mean of sum of all individual measurements for septic procedures: 401.7 ± 176.3 CFU/m³; for aseptic procedures: 388.2 ± 178.3 CFU/m³; $p = 0.69$) (Table 1) and for microbial load 30 minutes after the beginning of procedures, at the end of procedures (closure), and 30 minutes after closure (Table 1). Comparison of the

sampling locations near to the operating field (N1, N2) and further from it (F1, F2) also showed no significant differences between the values for septic and aseptic procedures ($p = 0.052$ and 0.325 respectively).

Qualitative analysis: For both types of procedures the most common pathogens were coagulase-negative staphylococci (CNS), followed by Micrococcus (M.) luteus and aerobic spore-forming bacteria (Table 2). For septic procedures only, *Escherichia (E.) coli*, *Proteus (P.) mirabilis*, and *Enterococcus (E.) faecalis* were found, in addition to skin flora and ubiquitous spore-forming bacteria ($n = 22$ samples, 4 to 20 CFU/m³ per sample) (Table 2). Thirty minutes after the end of procedures, only *E. faecalis* (in $n = 2$ samples, 4 and 8 CFU/m³ respectively) and *E. coli* (in $n = 1$ sample, with 4 CFU/m³) were detected. For aseptic procedures only, *Staphylococcus (S.) aureus* and *Pseudomonas (P.) stutzeri* (in $n = 9$ samples, with 4 to 20 CFU/m³ per sample) were detected (Table 2, Table 3). No multiresistant bacteria were found. Substantially more aerobic spore-forming bacteria were released with septic procedures than with aseptic procedures (Table 2).

Microbial sedimentation

Quantitative analysis: No significant differences were detected in microbial sedimentation between septic and

aseptic procedures at sampling locations S1 or S2 ($p = 0.603$) (Table 1). There was also no significant difference in the microbial load of the walls (beginning of procedure/incision: $p = 0.16$, end of procedure/closure: $p = 0.69$) (Table 1).

Qualitative analysis: At sampling locations S1 and S2, for both types of procedures, CNSs were the most common pathogens, followed by aerobic spore-forming bacteria (Table 2). *E. coli* was found for septic procedures only. *Streptococcus spp.* were more common with aseptic procedures than with septic procedures (Table 2).

On the walls, colonies developed on only 60.7% (216/356) of the sedimentation plates. For both types of procedures (septic and aseptic) the most common pathogens were CNS (approximately 50%), followed by aerobic spore-forming bacteria (17% versus 33%), *M. luteus* (17% versus 10%), and molds (10% versus 7%). *Streptococcus spp.* were found for septic procedures only (6%). Because the power of the analysis was limited by the small amount of data, no significance calculation was performed. There was no microbial sedimentation of *P. mirabilis*, *E. coli*, *E. faecalis*, *S. aureus*, or *P. stutzeri* either at sampling locations S1 or S2 or on the procedure room walls.

Discussion

This study found neither qualitative nor quantitative differences between the microbial load of procedure room air or microbial sedimentation for septic and aseptic procedures within general and visceral surgery. When interpreting the findings reported here it should be noted that the study was not originally planned as an equivalence or noninferiority study. The fact that the differences between the 2 procedure types were statistically insignificant cannot therefore be interpreted as direct evidence of equal microbial load. However, the consistency of the findings at the various stages of analysis does suggest that a non-inferiority study planned to confirm these findings would yield comparable results. This is in line with the findings of Daschner et al. (22). Weist et al. (20) actually found a lower microbial load of procedure room air for septic procedures, though also with a higher proportion of typical nosocomial pathogens.

The mean microbial load of the air in the procedure room can be used as an indirect indicator of infection risk to the extent that the correlation between surgical wound infections and increased bacterial load in procedure room air following hip and knee replacement surgery is confirmed (23, 24).

The differences between surgery duration for the two procedure types can be explained by the fact that septic procedures were typically for the treatment of skin and soft tissue infections, whereas most aseptic procedures involved visceral surgery and thus longer procedures.

Microbial load of procedure room air is known to increase with the number of people present and the level of activity in the procedure room during surgery

(25–27). Because the difference between the number of people present at the two procedure types was insignificant, it is unlikely that this parameter affected the microbial load of the procedure room air in this study. It is likely that activity levels were higher for orthopedic procedures, but the study findings do not indicate this. Finally, the increase in surgical wound infection rates in noisy conditions (28) and when non-surgery-related conversations are held (29) should be mentioned; this study did not examine these two issues.

The literature provides evidence of a time-dependent difference in microbial load of procedure room air (20, 30). However, despite the lack of a ventilation system, this study did not confirm this.

As a limitation, it should be noted that only the mean microbial load of the procedure room air at 30-minute intervals was measured, not maximum peak loads. Weist et al. describe greater contamination of the area close to anesthesiologists and the space between sterile and nonsterile areas for septic procedures than for aseptic procedures (20). This study did not confirm these findings, either near to or further from the operating field.

As in the work by Friberg et al. (31), measurement of microbial sedimentation revealed a correlation between it and microbe levels in procedure room air. The greater release of *Streptococcus spp.* for aseptic procedures and of molds for septic procedures may be due to the fact that *Streptococcus spp.* are released from the oral cavity and respiratory tract and reach higher levels during aseptic procedures because these are on average substantially longer, while molds are probably agitated due to the higher level of activity of the surgical team. The fact that CNS and aerobic spore-forming bacteria are generally the most common pathogens is stated in multiple sources in the literature but is not microbiologically relevant to the procedures examined here (22, 32).

A potentially higher risk might be inferred only from the isolated occurrence of *E. coli*, *E. faecalis*, and *P. mirabilis* in septic procedures within 30 minutes of the end of surgery. However, even at a distance of 50 cm from the operating field only 2 CFU of *E. coli* were detected once, in only one septic procedure, and there was no sedimentation of *P. mirabilis* or *E. faecalis* near to the operating table.

Summary

The size of the sample does not allow a surgical wound infection rate to be inferred. Even if isolated pathogens remained in the air of the procedure room until the next procedure, which would only be possible in procedure rooms with no ventilation systems, levels would still fall far short of the threshold dose necessary to cause a surgical wound infection (Table 2, Table 3). For example, for transurethral application of *P. mirabilis* the threshold is 10^6 CFU (33); for surgical wound infections in animal experiments, the threshold for *S. aureus* is 10^3 to 10^7 CFU, for

P. aeruginosa 10^3 to 10^5 CFU, and for *B. fragilis* and *E. coli* 10^5 to 10^8 CFU (34). Because modern surgical procedure rooms are fitted with ventilation systems with recovery times of no more than 20 minutes, after 30 minutes the aerogenic contamination risk for the next patient is very low. Where ventilation systems are present, the microbial load of the surroundings is quantitatively reduced by similar amounts for both septic and aseptic procedures, so no difference between the two is to be expected, but the risk of contamination is far lower than when there is no ventilation system.

Not establishing spatial separation between septic and aseptic procedures can be recommended without increasing the risk of infection, provided that basic hygiene measures are implemented, the surgical procedure room is not entered before the end of the stated induction period of surface disinfection, and the time interval between 2 procedures is sufficient (more than 30 minutes).

Our data does not indicate whether the conclusion that spatial separation between septic and aseptic procedures is unnecessary can be extrapolated to orthopedic/trauma surgery, particularly endoprosthetic implantation. However, as the literature provides no evidence that a lack of such separation is associated with an increased risk of infection, it can be presumed that if ventilation systems are of sufficient capacity a lack of separation does not increase the risk of infection.

This might not only lead to financial benefits for surgery departments as a result of better use of surgical capacities and lower construction-related investment costs but would also allow for more flexible planning in line with urgency of surgery rather than the required sequential order of septic and aseptic procedures. It is, of course, also possible to have a separate septic procedure room with entrance and exit points for reasons of capacity use, although this does not yield any additional benefit for patient safety.

Conflict of interest statement

Prof. Assadian has received consultancy fees from Mölnlycke Health Care, Hutchinson Santé, and Ethicon. He has received reimbursement of travel costs and lecture fees from Ethicon.

Prof. Kramer has received reimbursement of travel costs and lecture fees from Ethicon.

The other authors declare that no conflict of interest exists.

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KEY MESSAGES

- Despite the lack of a ventilation system, there was no significant difference in microbial levels in the procedure room air between septic and aseptic procedures throughout surgery time.
- There was also no significant difference in microbial sedimentation 0.5 m or 1.5 m from the operating field or on the walls of the procedure room.
- Isolated pathogens at a level of approximately 400 CFU/m³ remained in the procedure room air until the next procedure. This is substantially less than the pathogen-specific dose of 10^3 to 10^8 CFU/m³ required to cause a surgical wound infection.
- As there are no differences in microbial load either near to or further from the operating field, there is no reason to conclude that septic and aseptic procedures must be spatially separated, even if there is no ventilation system.
- This study was not planned as an equivalence or noninferiority study. This must be taken into account when interpreting its findings.

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CLINICAL SNAPSHOT

The Cobblestone Sign in a Child with Crohn's Disease

In this case, terminal ileitis with a typical cobblestone-like relief pattern was seen at the time of diagnosis of Crohn's disease (*Figure*). The patient, a 12-year-old girl, complained of having suffered from abdominal pain that had recently worsened, along with recurrent, sometimes bloody diarrhea, for the past five years. She dropped on her weight curve from the 75th to the 25th percentile. One year earlier, she had undergone a procedure for the treatment of a gluteal abscess. She also recalled having had mouth sores. Crohn's disease often manifests itself in a latent manner in childhood and adolescence, with uncharacteristic or heterogeneous signs and symptoms, even though its severity and course are worse overall than in adulthood.

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Conflict of interest statement

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