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Letter to the Editor

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Sir,

Ultra-clean ventilation systems are used in the operating room (OR) to reduce the quantity of airborne bacteria in the ultra-clean area, and reduce the incidence of surgical site infections (SSIs) [1]. When the number of colony-forming units (CFUs) in the ultra-clean (protected) area is too high, this is considered a risk factor for SSIs [1].

Underneath an uni-directional air flow (UDAF) system, there should be $<$10 CFU/m^3 during infection-prone surgery [1]. However, for large infection-prone procedures, the protected area of a UDAF system is sometimes too small to contain all sterile instrument tables, and to allow sufficient additional space between sterile staff and instrument tables [2,3]. When instrument tables are located partially outside the protected area, this peripheral area should also meet the required cleanliness level of $<$10 CFU/m^3 [4].

Standards and guidelines [4—6] focus solely on air quality of the UDAF in the, by most standards, pre-defined protected area. Air quality in the periphery, outside the protected area of a UDAF system, is not taken into account [4—6]. As such, the aim of this study was to determine the quality of air in the periphery of the OR by measuring the number of CFUs during surgery.

Peripheral CFU measurements were taken at two different locations in one hospital organization in the Netherlands. The type of surgery was noted, and described as infection prone or generic.

The ORs (Table I) were equipped with a UDAF system that introduced air directly (and solely) above the protected area, and not directly into the periphery. The staff present during surgery wore modern scrub suits made of 99% polyester and 1% carbon fibres. The source strength using this type of clothing was 2.9 (0.9—5.7) CFU/s/person [7].

CFU measurements were taken at two fixed locations in the periphery, outside the protected area of the UDAF, using a Sampl'air sampler (bioMérieux, Marcy l'Etoile, France). The locations were selected as they are often, at the study hospital, used for instrument tables during (large) surgical procedures. CFU measurements were taken based on the Swedish standard [4]. Four moments were defined to measure the number of CFUs: patient on table (during positioning of the patient, before commencement of surgery), at incision, between incision and closure (at 10 min), and during closure of the wound.

The measurement cycle of each sample at the location measured was 2.5 min, and 250 dm^3/min was sampled. Air sampling started directly after the incision was made, and was repeated several times during sugery. The final measurement was taken during wound closure. The agar plates (bioMérieux COS) were incubated aerobically for 2x24 h at 37 °C. During the measurements, the number of staff present, number of door openings and duration of surgery were noted.

The results (Table I) show that the number of CFUs in the periphery between the start of incision and wound closure, in 58 surgical procedures, did not exceed the international accepted level of $<$10 CFU/m^3 [1] in approximately 82.4% (103 measurements) of cases. The mean CFU/m^3 in the periphery was 5.9 [standard deviation (SD) 5.8]. The average duration of surgery was 56.9 (SD 50.6) min. During surgery, the average number of staff was 7.6 (SD 1.1, N=54), and there were 6.4 (SD 8.3, N=53) door openings.

With a total of 125 measurements, the highest accepted level of 30 CFU/m^3 [5] was exceeded three times at incision and four times during surgery. This was the highest [4] accepted value for a single measurement during a surgical procedure. Higher numbers may have been measured during surgery because of activities in the OR, such as changing the OR team or bringing in equipment necessary for the surgical procedure.

The number of CFU/m^3 when the patient was positioned on the OR table before incision was, on average, 36.9 (SD 48.8). In 35.4% of cases, the level of CFUs was $<$10 CFU/m^3. These numbers, when the patient was positioned on the OR table, were high and do not comply with the standard, but the numbers were reduced to $<$10 CFU/m^3 at incision in 45 of the 57 cases (78.9%). After 10 min, the number of CFUs was $<$10 CFU/m^3 in 83.8% of cases, and at the end of the surgery (during wound closure), the number of CFUs was $<$10 CFU/m^3 in 77.8% of cases.

In conclusion, the number of CFUs did not exceed 10 CFU/m^3 in 82.4% of the measurements taken in the periphery. Air

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Table I
Operating room (OR) location, room size, air changes and type of ultra-clean ventilation system, and colony-forming unit (CFU) measurements in the periphery

OR type	Hospital location	System type (no. of ORs)	Surface UDAF (m^2)	OR length (m)	OR width (m)	OR height	OR volume (m^3)	Total air volume (m^3/h)	Air changes (*N*)
1	A	UDAF (10)	6.4	7.4	5.9	2.8	123	5593—7282	46—59
2	A	UDAF (2)	5.7	5.4	6.2	2.8	96	5599—6013	58—63
3	B	UDAF (10)	7.1	6.8	6.1—6.9	3	127—142	7412—8690	56—68

CFU measurements in periphery					
	Patient on table	At incision	At 10 min	At wound closure	
N	48	57	37	54	
Number of CFUs (CFU/m^3), mean (SD)	36.9 (48.8)	7.0 (10.7)	5.0 (6.7)	6.2 (9.5)	
<10 CFU/m^3	35.4%	78.9%	83.8%	77.8%	

UDAF, uni-directional air flow; CFU, colony-forming unit; SD, standard deviation.
Results are presented as mean (SD).

quality in the periphery of ORs may be good enough to position instrument tables safely when the pre-defined protected area [8] of the UDAF ultra-clean ventilation system is not sufficiently large.

Conflict of interest statement
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