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Letters to the Editor

Preliminary study of the air quality in operating rooms: do textiles have a role?

Sir,

Although air quality control is routinely performed in operating rooms, and high-efficiency particulate air (HEPA) filters ensure that operating rooms reach the required air standards, surgical textiles releasing inert particles may worsen air quality [1–3]. Italian hospitals mostly use cotton drapes and disposable non-woven fabric (NWF) gowns. Cotton drapes are economic and reusable but release a high number of inert particles. NWF and reusable technical textile (RTT) surgical drapes and gowns both release fewer particulates. However, NWF products, being disposable, have a higher impact on the environment than RTT ones that can be reused [4]. We evaluated inert particulate levels and microbiological contamination in four operating rooms of an Italian teaching hospital after the exclusive use of NWF or RTT gowns and drapes. Technical features of the textiles are described elsewhere [4].

The study was performed from August to October 2017 in two abdominal surgery units (SU-A and SU-B) of a teaching hospital.

From each SU, tests were performed in two different 36 m^2 operating rooms (OR-A1, OR-A2; OR-B1, OR-B2), characterized by a conventional turbulent mixed flow (air flow rate of 3000 m^3/h) with HEPA filtering [5]. Before the start of the study, in all the operating rooms healthcare personnel wore NWF textiles. After the start of the trial, only RTT gowns and drapes were used in OR-A1 and OR-B1, whereas OR-A2 and OR-B2 were dedicated to the exclusive use of NWF.

Particle counts (0.5 μm and 5 μm) and microbiological sampling were performed before the surgical practices, at the centre and four corners of the room, while the ventilation systems were active.

Particles of 0.5 μm were counted for the ISO class detection, as described by ISO 14644-1, whereas the possible size of bacteria-carrying particles is 5 μm [1].

Particle counts were monitored in all the ORs at different times from the NWF/RTT introduction (see Table I footnote). Particle count samplings were performed by the Hach Met One 3313 Particle Counter (Ashtead Technology, Sandy, UK).

Table I shows the particle counts found in SU-A and SU-B, with the respective ISO classification. Friedman statistical test and Nemenyi procedure were used to evaluate the particle count variation. Significant reductions of 0.5 μm particulate levels were observed at T2 and T4 in both ORs ($P = 0.0003$, $P = 0.0001$, respectively); reductions in 5 μm particulate matter levels at T2, T3, and T4 were observed in operating room A1 ($P = 0.0008$, $P = 0.0004$, $P = 0.01$, respectively).

At T0, T3, T5, microbiological air-sampling was performed at the corners and centre of the room using the Surface Air System (SAS) sampler (Microflow Aquaria, Milan, Italy), while four surfaces (bed, lamp, door, monitor) were sampled at the same times with Contact Agar Plates (VWR, Milan, Italy), as described elsewhere [6]. Results showed the absence of pathogenic micro-organisms. Total microbial counts at 22/37°C were always <1 cfu/m^3 (air) and <1 cfu/cm^2 (surfaces).

The aim of this study was to evaluate the effect of surgical textiles. At basal condition, before the NWF/RTT introduction, a large difference in air quality between the two settings was observed. In SU-A air quality at T0 was suboptimal (ISO 6); this critical issue was immediately communicated to the Hospital Technical Unit. After the introduction of NWF and RTT, we found a significant decrease in air particulates at T2, T3 and T4, a non-significant increase at T1 and T3, and a significant increase at T5, after the reintroduction of cotton drapes. T0 was measured after the operating rooms had not been used in the previous two days so T5 probably better represents the basal condition of the operating rooms. In T4, after 11 days of using low-lint textiles, the operating rooms could be reclassified in the ISO 5 class. The exclusive use of NWF or RTT gowns and drapes was associated with a similar improvement of the air quality in the two operating rooms. These findings suggest that removal of cotton textiles can help achieve the required standards in operating rooms.

In SU-B air quality at T0 was optimal (ISO 4) and a steady condition of air quality was observed during the study. Overall, no difference between NWF and RTT gowns and drapes was observed during the whole study; this may be due to the high efficiency of the operating room ventilation system. Arguably, differences between different textiles could be better assessed in an operating room where many healthcare workers are present.

Within the limitations of this preliminary research (short period of study and absence of sampling during operative procedures) our data suggest that replacing traditional

Table I
Particle counts (0.5 μm and 5 μm) detected in operating rooms at various times (T0—5)

Surgery unit	Operating room (textile type)	Particle size	Particle counts					
			T0	T1	T2	T3	T4	T5
SU-A	OR-A1 (RTT)	0.5 μm:						
		Mean ± SD	$1.6\times10^4 \pm 5.3\times10^2$	$1.7\times10^4 \pm 1.4\times10^4$	$5.7\times10^3 \pm 6.8\times10^2$	$1.5\times10^4 \pm 3.6\times10^3$	$3.1\times10^3 \pm 1.4\times10^3$	$4.2\times10^4 \pm 1.2\times10^4$
		Median	1.6×10^4	9.7×10^3	3.4×10^3	1.4×10^4	3.1×10^3	4.2×10^4
		ISO Class	5.7	5.9	5.4	5.9	5.1	6.2
		5 μm:		5	5	5	5	5
		Mean ± SD	$2.1\times10^3 \pm 1.9\times10$	$7.8\times10 \pm 5\times10$	$1.9\times10 \pm 0.3\times10$	$6.4\times10 \pm 2\times10$	$4.2\times10 \pm 2\times10$	$3.7\times10^3 \pm 2\times10$
		Median	1.1×10^2	7.1×10	0	3.6×10	3.5×10	3×10^3
	OR-A2 (NWF)	0.5 μm:						
		Mean ± SD	$1.5\times10^4 \pm 1.3\times10^2$	$3.4\times10^4 \pm 3.1\times10^4$	$7\times10^3 \pm 3.7\times10^3$	$1.6\times10^4 \pm 1.1\times10^4$	$4\times10^3 \pm 1.2\times10^3$	$1.3\times10^4 \pm 1.1\times10^4$
		Median	1.5×10^4	2.2×10^4	6.6×10^3	1.1×10^4	4.1×10^3	9.1×10^3
		ISO Class	5.6	6.3	5.5	5.9	5.2	5.8
		5 μm:						
		Mean ± SD	$9.6\times10 \pm 9\times10$	$9\times10 \pm 8\times10$	$7\times0.1 \pm 0.07\times10$	$3.9\times10^2 \pm 2.1\times10$	$9.7\times10 \pm 2.1\times10$	$8.1\times10 \pm 1.9\times10$
		Median	7.1×10	7.1×10	0	3.6×10	7.1×10	7.1×10
SU-B	OR-B1 (RTT)	0.5 μm:						
		Mean ± SD	$1.3\times10^2 \pm 1.2\times10^2$	$5.4\times10^2 \pm 3.1\times10^2$	$1.3\times10^2 \pm 1.1\times10^2$	$2.6\times10^2 \pm 2.1\times10^2$	$8.9\times10^2 \pm 6.6\times10^2$	$9\times10^2 \pm 8.3\times10$
		Median	1.1×10^2	4.2×10^2	1.1×10^2	1.4×10^2	7.5×10^2	9×10
		ISO Class	3.8	4.4	3.8	4.2	4.6	4
		5 μm:						
		Mean ± SD	$1.2\times10 \pm 1\times10$	$8.2\times10 \pm 7.5\times10$	$1.9\times10 \pm 1\times10$	$3.1\times10 \pm 2.8\times10$	$1.6\times10^2 \pm 4.4\times10$	$3.3\times10 \pm 2.2\times10$
		Median	0	3.6×10	0	0	7.1×10	0
	OR-B2 (NWF)	0.5 μm:						
		Mean ± SD	$2.9\times10^2 \pm 1.5\times10^2$	$6.7\times10^2 \pm 4.1\times10^2$	$1.6\times10^2 \pm 1.2\times10^2$	$3.1\times10^2 \pm 1.3\times10^2$	$7.4\times10^2 \pm 2.7\times10^2$	$2.5\times10^2 \pm 1.1\times10^2$
		Median	2.9×10^2	6.4×10^2	1.6×10^2	2×10^2	7.4×10^2	2.5×10^2
		ISO Class	4.1	4.5	3.9	4	4.4	3.7
		5 μm:						
		Mean ± SD	$1.1\times10^2 \pm 8\times10$	$1.4\times10^2 \pm 1.1\times10^2$	$4\times10 \pm 3.8\times10$	$3.8\times10 \pm 2.4\times10$	$1.4\times10^2 \pm 9\times10$	$3.5\times10 \pm 2.8\times10$
		Median	7.1×10	1.1×10^2	3.5×10	3.5×10	1.4×10^2	3.5×10

T0: before 24 h, basal condition; T1: after 24 h; T2: after 72 h; T3: after 7 days; T4: after 14 days; T5: 7 days after reintroduction of NWF gowns and cotton drapes.
RTT, reusable technical textile; NWF, disposable non-woven fabric.

cotton surgical drapes with low-lint textiles such as NWF or RTT might reduce inert particulate levels in surgical areas. Whether this would have any impact on infection rates is uncertain.

Conflict of interest statement

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Laminar airflow system use across the operating surface for airborne infection prevention in office-based surgical procedures

Sir,

Paradigm shifts in efficiency, infection control and cost-effectiveness have seen a tremendous expansion in office-based procedures over the last several years. Office-based procedures offer both doctors and patients more convenience and efficiency, and advances in medical technology have made it possible to perform procedures previously only thought of in an operating theatre environment. However, a major concern with office-based procedures has surrounded ensuring the microbiological safety of the environment. We report on our experience with a novel unidirectional laminar airflow system, SurgiCube (SurgiCube International, Vierpolders, The Netherlands), in performing office-based intravitreal injections.

There are currently no international standards for acceptable quality air within the operating room environment. Comparisons are often made with the International Organization for Standardization's standard for cleanrooms and associated controlled environments (ISO 14644-1:2015). This standard relies solely on the concentration of airborne particles. However, the efficiency of a clean air ventilation system in a clinical setting can be determined by its ability to filter out bacteria-carrying particles. This can be performed by two methods: particle counts in the air flow with the use of a light scattering airborne particle counter, or measurement of colony-forming units (cfus).

The manufacturer's testing of the SurgiCube laminar air flow system in a true surgical environment indicated an average of 666 particles ($\geq$0.5 μm) and 0.12 cfu/m^3 across the operating surface with a 95% confidence interval [1]. Compared with the background air quality outwith the operating surface, but within the same room, this represented 470 times fewer particles of $\geq$0.5 μm, 725 times fewer particles of $\geq$5.0 μm and 126 times fewer cfu/m^3 [1]. These values are as good as, or better than, the current ISO classification.

We carried out a prospective cohort study between December 2016 and January 2018 of all patients treated consecutively by three surgeons with intravitreal injections at a single centre in Tasmania, Australia, equipped with the SurgiCube laminar airflow filtration system. All injections were carried out under sterile conditions with pre-injection chlorhexidine antiseptic wash, eyelid speculum, mask, sterile gloves and drapes, and post-injection normal saline 0.5% wash and application of chloramphenicol ointment as standard practice. Each injection was recorded in an electronic database, which also recorded the incidence of endophthalmitis.

In total, 1544 injections were performed in 220 patients during the study period; each patient received a mean of seven injections (standard deviation 4.7, range 1–23). The intravitreal injections consisted of ranibizumab (N = 1065), aflibercept (N = 452), bevacizumab (N = 22) and triamcinolone