Mobile laminar flow screen for additional operating room ventilation - technology for reduction of bacteria and air-borne particles contamination

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Summary

•Objective: efficacy of mobile laminar flow screen through the evaluation of air-borne particles and bacteria contamination in an Operating Room (OR) with standard turbulent ventilation;

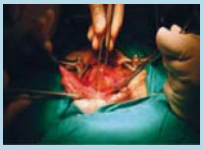
•Results: significant reduction of air counts of bacteria and air-borne particles in wound area when additional screen is used;

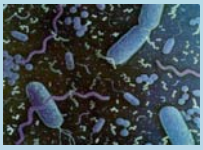
•Conclusions: mobile screen is an effective addition in OR with standard turbulent ventilation where good asepsis level is necessary (major surgery, prosthesis implant).

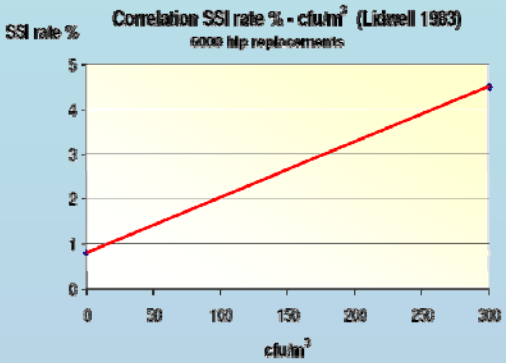
Introduction

Surgical site infections (SSI) represent a weighty problem in surgery quality, causing suffering, mortality and excessive costs. Air is an important carrier of infection in OR especially in major surgery. Systems for ventilation of OR are the first way to reduce microbe contamination. Ultra-clean laminar air flow systems are used for implant surgery but they are costly and require large installation space. Conventional turbulent ventilation is not the optimum system for implant surgery.

Mobile laminar flow screen (Fig. 1) is used in addition to conventional turbulent ventilation to guarantee a good level of microbe contamination for implant surgery in wound area.







Objective

Efficacy of mobile laminar flow screen through the evaluation of air-borne particles and bacteria contamination in an OR with conventional turbulent ventilation and their reduction with mobile screen in addition.

Figure 1: LAF screen used in the experiment.

Methods

The experiments were performed in an OR of Orthopedic Surgery of A.O.U. San Martino. OR was equipped with a conventional turbulent ventilation system (12,5 air changes/h).

We performed 68 air samples on wound (34 with mobile screen, 34 without) during **6 operations of knee prosthesis implant** and **3 sham surgery** to compare bacterial and particle contamination in wound area with and without mobile screen.

CFU/m³ was measured using Biotest RCS sampler (50 l/min) during surgery. Sampling time was 10 min. Agar stripes were incubated for 48h at 37°C before counting CFU.

Air-borne particles/m³ was measured simultaneously in the same area using Biotest APC (2,8 l/min). Sampling time was 10 min.

The additional mobile screen consisted of a box with a fan and a HEPA filter (99.999%). The screen produced a laminar air flow at 0,5 – 0,7 m/s on wound (Fig. 1).

Sampling methods and experimental setup are shown in Table I and Figure 2.

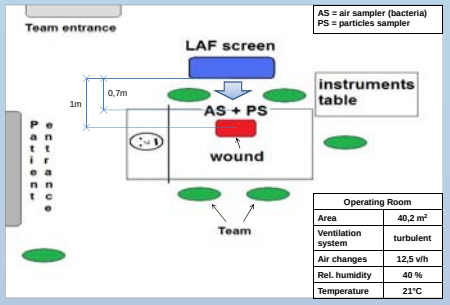


Figure 2: OR and experimental setup.

Results

Using additional mobile screen during surgery, air contamination (CFU/m³) in the wound area decreased of 84% and was below the accepted limit for OR with ultra-clean laminar ventilation system (< 20 CFU/m³, ISPESL guidelines) (Table II, Figure 3). At the same, air-borne particles (d = 0,5μm) in wound area decrease of 98% (Table II, Figure 4).

	Air counts of bacteria [UFC/m³] (Biotest RCS Sampler)	Air counts of particles [Part./m³] (Biotest APC Sampler)
Sampling capacity	50 l/min	2.8 l/min
Sampling time	10 min	10 min
Sample volume	500 l	280 l
Number (location) of samples	34 (wound)	34 (wound)
Total number (location) of samples	68 (34 with screen on wound; 34 without screen on wound)	

Table I: sampling methods used in the experiment and number of samples performed.

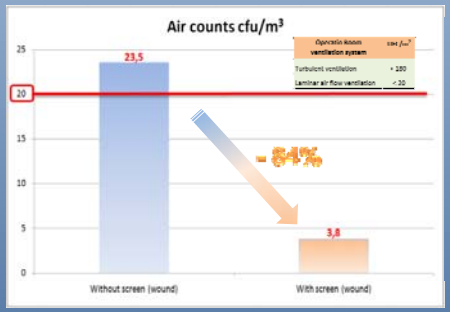


Figure 3: air counts cfu/m³ on wound area with and without additional screen and ISPES guidelines about OR cfu/m³ limits.

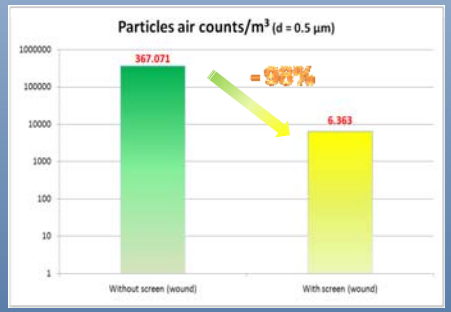


Figure 4: particles air counts on wound area with and without additional screen.

Variable	Particle size	With screen	p-value	Without screen
CFU/m³ (wound area)		3,8	0,00001	23,5
n° samples		17		17
Particles/m³ (wound area)	0.3 μm	95.255	0,0381	4.223.553
	0.5 μm	6.363	0,0124	367.071
	1 μm	1.725	0,0114	118.929
	5 μm	0	0,0022	1.188
n° samples		17		17

Table II: air contamination with particles/m³ and CFU/m³ in wound area.

Conclusions

The additional laminar flow screen reduced bacteria and air-borne particles in wound area carrying them below levels accepted for OR with ultra-clean laminar ventilation system. This solution is very interesting in implant surgery OR where laminar flow system is impossible to install (extensive rebuilding, too expensive). However, observation of correct procedures and OR staff behavior are the basis for a good operation of ventilation systems and asepsis level in OR.

References

•ISPESL OR guidelines.

•Additional mobile ultra-clean exponential LAF screen in conventional OR ventilation reduced bacterial contamination to operating box levels – S. Friberg et al Umeå University, Sweden.