

Analysis of Environmental Conditions in the Operating Room for Latex-Allergic Patients' Safety

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Purpose: Most current protocols agree that latex-sensitive patients should be scheduled for elective surgery as the first case of the day with a 12-hour activity-free interval before surgically treating latex-allergic patients.

Design: To understand the kinetics of decontamination of airborne particles in the operating room (OR) after a surgical procedure to determine the activity-free interval necessary between surgeries for latex-allergic patients.

Methods: This observational study included 12 ORs in four hospitals. Baseline levels of airborne particles were established before surgery.

Findings: Mean recovery time of ORs was 18.9 ± 6.5 minutes. To guarantee an efficacy of 99.9%, two standard deviations were added to the maximum time (28 minutes). Total recovery time: 32 minutes.

Conclusions: ORs that complied with the requirements of our study before performing surgery on latex-allergic patients obtained the same environmental conditions as first thing in the morning after thorough cleaning of the OR and a 32-minute activity-free interval and staff traffic restriction.

Keywords: allergic patients, latex, operating room, anaphylaxis, kinetics of particles.

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MOST CURRENT PROTOCOLS in surgical areas recommend a 12-hour activity-free interval before surgically treating patients who are hypersensitive to latex.¹⁻³ The interest for air quality in the operating room (OR) to avoid infections started at the beginning of the 20th century. The first studies on this issue published in 1946 are attributed to Bourdillon-Colebrook, who recommended improved ventilation systems because surgical rooms were only equipped with exhaust fans, but no clean air inlet. Such improvements

achieved adequate environmental conditions but did not prevent ingress of contaminated air into the operating theater from other contaminated areas. Recommendations regarding the assurance of air quality, the control of airborne particles in different procedures and spaces, and the number of air renovations (between 20 and 30 per hour) were later incorporated. It was not until 1960 that Blowers and Crew established the principles of an effective ventilation system for operating theaters.⁴

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Latex is the substance obtained from the sap of the *Hevea brasiliensis* tree. Its protein content is between 1% and 1.8% and 13 allergens have been identified. These proteins can also be found in some foods, and cross-reactions may occur between latex-allergic individuals and the ingestion of such food items.⁵ References about hypersensitivity to latex were found in 1927 and later in 1979, but the number of individuals with latex hypersensitivity rose in the 1990s. This increase was the result of the greatly increased use of latex gloves and products made of raw latex, following international guidelines that recommend the use of gloves since the appearance of the human immunodeficiency virus as a measure for preventing the propagation of infectious diseases.^{6,7}

In the past years, latex allergy has become a major health concern that affects health care workers⁸⁻¹⁰ and the general population. Other risk groups include individuals allergic to tropical fruit (eg, banana, kiwi) or other types of fresh or dried fruits, patients diagnosed of atopy, dermatitis, asthma, allergies, and exposed workers such as kitchen and cleaning staff.

Latex allergen (latex proteins) contact and/or exposure may occur via cutaneous, percutaneous, mucosal, or parenteral routes. Inhalation of latex particles occurs when the proteins combine with the powder from the gloves and form aerosolized particles that become airborne. Reactions caused by hypersensitivity to latex can range from contact urticaria, angioedema, rhinoconjunctivitis, bronchial asthma, and even anaphylactic shock.

The prevalence of latex allergy according to a report by the Catalan Society of Allergy and Clinical Immunology is estimated at 1% for the general population. This figure increases in risk groups: 3% to 11% in health care professionals, 8% to 10% in surgical staff and dentists, and 30% to 50% in patients with urogenital disorders and with multiple surgery.^{5,11}

Latex is used to manufacture medical gloves, material, equipment, and devices. As gloves are the first barrier used by health care professionals, their use is indispensable in surgical areas and is closely correlated with the high levels of airborne allergens. The studies performed on the use of powdered and powder-free gloves have shown that latex protein concentrations are lower when powder-free gloves are used.¹²

Several studies have demonstrated that the risk of developing hypersensitivity to latex is higher when powdered gloves are used.^{9,13} Related factors are glove protein and lubricating powder. A number of investigations have shown that the concentrations of airborne allergens range between 8 and 974 ng/m³ in areas where powdered latex gloves are used and between 0.3 and 1.8 ng/m³ where powder-free latex gloves are used.^{14,15}

The OR is an area of great activity, subject to constant changes (surgical techniques, physical structure, equipment, furniture, materials, and drugs) and is considered a high-risk area. It is therefore important to know the components of the materials used in the manufacture of all devices and materials and identify and verify their correct functioning. Maintenance of the parameters of the ventilation system should be established according to the legislation in force.^{16,17}

Installations should ensure a clean airflow to allow dilution of the contamination generated by surgical equipment and individuals in the surgical room. The air pressure should ensure an airflow path from clean to less clean areas and an airflow pattern that shifts contaminated air in areas that require special protection (surgical area and instrument tables) to minimize the level of airborne contamination.^{18,19}

Experience has shown that ORs at risk for a higher presence of bacteria and potential for contamination should be equipped with fans at 2,400 m/hour when equipped with mixed air systems and include a minimum of 20 air changes/hour.²⁰

Particles are solid or liquid matter shed into the air. Particle concentration is an indicator of the air quality in the OR. Depending on the type of premises, several stages of filtration are required to eliminate particulate pollutants.

The criterion established to operate on latex-allergic patients in the sites participating in the present study is to schedule them for elective surgery as the first case of the day. This measure is taken as airborne latex-laden particles are presumed to be at their minimum levels at that time, because there has been no activity since the previous day. Reproduction of this "first case of the day" environment would allow modifying the present protocols that require a 12-hour interval between

surgeries. Measurement of particle concentrations should therefore be made to establish the interval necessary between surgical procedures.

The elimination of airborne latex particles will depend on the effectiveness of ventilation of the premises and our ability to avoid the use of latex-containing materials in the OR (minimize the use of latex products, especially powdered gloves).

Methods

Design and Setting

An observational, analytical study was performed between October 2011 and July 2013. Sixteen hospitals belonging to our group (Association of Surgical Unit Management) participated in the study.

Review of Protocols

The managing nurses who collaborated in this study reviewed prevention and action measures to be taken by each site when caring for latex-allergic patients scheduled for surgery. Managing nurses were also responsible for reviewing the guidelines established by different scientific societies^{1,21-24} and associations of affected patients. Most protocols for the management of latex-allergic patients recom-

mend a 12-hour activity-free interval before surgically treating latex-allergic patients.

Sample Selection: Study on the Kinetics of Latex Particles

The study of kinetics of particles was performed by random sampling of the 131 ORs of the 16 associated hospitals. To obtain a confidence interval of 95%, an estimated precision error rate of 3%, and 97.75% probability of meeting the requirements of the present study, a minimum of 12 operating theaters had to be included. To facilitate sample collection, the following four hospitals that fulfilled the inclusion criteria were selected:

- Terrassa Hospital: Equipped with 383 beds, 80 of which are surgical beds; 12 surgical suites.
- Badalona Municipal Hospital: Equipped with 120 beds, 56 of which are surgical beds; four surgical suites.
- Sant Joan Despí Moisès Broggi Hospital: Equipped with 330 beds, 160 of which are surgical beds; 10 surgical suites.
- Igualada Hospital: Equipped with 244 beds, 87 of which are surgical beds; six surgical suites.

Box 1 describes the inclusion and exclusion criteria for the study.

Box 1

Inclusion Criteria

1. Sites affiliated to the "Health Prevention Association."
2. To participate in the study on the kinetics of particle decontamination, surgical rooms had to comply with a series of environmental and structural requirements. ORs with the following variables were included:
 - Air displacement (laminar flow) or dilution (turbulent flow) methods to partially eliminate contamination.
 - Surgical rooms classified as ISO 5, ISO 6, and ISO 7 air quality.²⁵ The ISO 14644-1:1999 series of standards that establishes a classification by airborne particle levels for clean rooms or clean zones. Maximum allowable concentrations (particles/m³ of air) according to the particle size are expressed in terms of ISO Class N.
 - Overpressure greater than 10 Pa.
 - ORs with three stages of filtration. The first level of filtration should be located outdoor (G4-F5). The second level of filtration is situated after the air cleaner and the beginning of the flow duct (F9). The third level of filtration should be an absolute filter placed in the terminal part of the air drive unit (high-efficiency particulate air 13 to 14).
 - Premises with clean air inlet that allows 20 air changes/hour. Air change rate/hour is calculated by dividing clean air supply rate by room volume.

Exclusion Criteria

Refusal to participate in the study.

Measuring Instrument

The analysis of airborne particles is carried out with a study on the kinetics of particle decontamination. The TSI AeroTrak Portable Particle Counter Model 9350-01, which counts airborne particles using a laser diode light source with an isokinetic probe and provides an accurate measurement of particles (0.3, 0.5, 1, 2, 3, and 5 μm), was used. Measurements are taken to determine activity-free interval between surgical procedures after cleaning.

Protocol of Measurement of Airborne Particles

Measurement of particles from 0.3 to 5 μm was taken when the surgical room was fully equipped (eg, instruments, furniture). Samples were collected at the operating table level (1.2 m above floor level). Staff traffic restriction was enforced: doors remained closed and only the technical team remained in the OR. Measurements took 1 minute with an airflow of 50 L/minute.

Measurements were taken three times during the surgical session:

1. *Before starting the surgical procedure:* No surgical activity since 15 hours of the previous day (16 hours rest) and traffic restriction. Thorough cleaning was performed after the last surgical procedure. Cleaning of surfaces and floor was done on the following day, at about 7 a.m., before measurements were taken by the technical team (protocol before starting surgical sessions) to assess baseline particle levels.
2. *Measurements between surgical procedures:* To establish the level of airborne particles during a surgical session, the team left after taking these measurements and surgery was performed without any activity-free interval between procedures.
3. *At the end of the surgical session and after cleaning of the OR:* The technical team entered the premises and took the measurements necessary until the same level of particles as before the surgical session started was reached (16 hours rest). The time required to recover baseline levels was then noted.

An “end of session” cleaning protocol was adopted:

- Cleaning and disinfection of stains on the walls and furniture with an intermediate level disinfectant.
- Cleaning with paper or a clean cloth. Disinfectant applied on the surfaces, making sure to reach all the corners, especially on the surgical table, surgical instruments and anesthesia material, auxiliary tables, and lamps. Keyboards, telephones, switches, and other surfaces of electrical appliances that are frequently touched cleaned with a damp cloth.
- Furniture moved to facilitate cleaning the floor and corners.
- Floor cleaned where the furniture was placed.
- All exterior surfaces of the furniture cleaned.
- All items of furniture returned to their original place when the floor was dry.
- The rest of the floor washed, paying special attention to the corners.
- No one to enter the OR until the floor was totally dry.

Survey on Type of Gloves Used

A survey was conducted by means of a questionnaire in the 16 collaborating sites to identify the different types of gloves used by professionals in the surgical areas. This questionnaire was completed by the OR nurse manager. Options included powdered and powder-free surgical gloves, powdered and powder-free examination gloves, and various types of materials (eg, latex, vinyl, nitrile, copolymer neoprene).

Statistical Analysis

The IBM SPSS Statistics Program 13 was used for statistical analysis. A general descriptive analysis of the variables studied was made. The Mann-Whitney *U* test was used to contrast hypotheses. A 5% confidence interval was obtained. This is a nonparametric statistical test that compares two means using independent samples, with small sample size and a non-normal distribution.

Results

Characteristics of ORs

The characteristics of the environment and the equipment in the 12 participating ORs are shown in [Table 1](#).

Trial on the Kinetics of Particle Decontamination

Table 2 shows the concentration of particles of 0.3, 0.5, and 5 μm at the three moments established in the trial in each OR. The last column shows the activity-free period necessary to recover baseline levels after cleaning each OR.

Mean recovery time of the ORs was 18.2 minutes with a standard deviation of 6.5, a minimum time of 7 minutes and a maximum of 28 minutes. Two standard deviations were added to mean recovery time to guarantee a 99% efficacy of recovery, amounting to a total of 32 minutes.

Recovery of baseline particle levels was obtained in the 12 ORs from a minimum of 7 minutes to a maximum of 28 minutes (Figure 1). When comparing mean baseline particle levels ($\bar{X}$) first thing in the morning (before starting the surgical session) with mean particle count ($\bar{X}$) after cleaning between surgeries, but without respecting activity-free interval, a significant difference was observed ($P = .005$).

When comparing mean baseline particle levels ($\bar{X}$) first thing in the morning with mean particle count ($\bar{X}$) after cleaning and respecting activity-free interval, the difference was not significant ($P = .164$). When comparing mean particle count ($\bar{X}$) after cleaning between surgeries, with no activity-free

interval, with mean particle levels ($\bar{X}$) after end of session cleaning with activity-free interval, the difference observed was significant ($P = .002$) (Table 3).

Types of Gloves

Sixty-two percent of the hospitals in our group use latex powdered gloves. Our results show that two of the hospitals (H2 and H4) included in our study on the kinetics of decontamination use this type of gloves (Figure 2).

Discussion

The preventive actions taken by health care professionals regarding the use of latex materials are similar in all the participating hospitals. Presently, most materials, furniture, equipment, structural materials, and medication are latex-free and all surgical areas have a list showing their contents. The risk of contamination is therefore minor and can be reduced by avoiding or regulating the use of powdered latex gloves and factors that affect the level of airborne particles. Latex powdered gloves are still widely used in surgical areas despite scientific societies' guidelines.

Several studies have related particle counts with the concentrations of airborne latex allergens when latex powdered gloves are used. They found

Table 1. Physical Characteristics of the Operating Rooms that Participated in the Study of the Kinetics of Particles

	Flow Type	N ISO 14644-1:1999	Pressure Difference	Stages of Filtration	No of Air Changes/Hour
H1 OR1	Turbulent	ISO 6	+26 Pa	G4/F9/H14	21
H1 OR2	Turbulent	ISO 7	+13 Pa	G4/F9/H14	22
H1 OR3	Turbulent	ISO 6	+20 Pa	G4/F9/H14	24.4
H1 OR4	Turbulent	ISO 6	+18 Pa	G4/F9/H14	24
H2 OR1	Turbulent	ISO 6	+12 Pa	G4/F9/H14	35.9
H2 OR2	Turbulent	ISO 7	+12 Pa	G4/F9/H14	33.7
H2 OR3	Turbulent	ISO 7	+12 Pa	G4/F9/H14	>20
H3 OR1	Turbulent	ISO 6	+20 Pa	G4/F9/H14	40
H3 OR2	Laminar	ISO 5	+22 Pa	G4/F9/H14	40
H4 OR1	Turbulent	ISO 7	>+10 Pa	G4/F9/H14	>20
H4 OR2	Laminar	ISO 6	>+10 Pa	G4/F9/H14	>20
H4 OR3	Turbulent	ISO 7	>+10 Pa	G4/F9/H14	>20

H, hospital followed by number assigned to center; OR, operating room followed by number assigned to studied OR, and always linked to center of reference.

Table 2. Kinetics of Particles at Three Stages of Surgical Session

Operating Room	Concentration of Particles/m ³ (Morning, Before Starting Surgical Session)			Concentration of Particles/m ³ (After Cleaning Between Surgeries)			Concentration of Particles/m ³ (After End of Session + Cleaning + Activity-Free Interval)			Activity-Free Interval (Minutes)
	0.3 μ m	0.5 μ m	5 μ m	0.3 μ m	0.5 μ m	5 μ m	0.3 μ m	0.5 μ m	5 μ m	
H1 OR1	1,993	1,181	133	384,780	139,420	2,220	2,160	1,113	113	27
H1 OR2	168,000	23,282	133	245,340	107,800	5,460	41,820	6,480	140	28
H1 OR3	4,230	3,120	290	29,240	7,320	290	5,820	2,080	40	22
H1 OR4	7,350	2,910	260	24,900	9,960	100	7,020	2,760	20	16
H2 OR1	5,640	3,680	260	71,720	38,280	1,360	1,960	1,360	40	23
H2 OR2	24,180	16,080	1,240	59,560	28,600	680	20,320	10,420	460	14
H2 OR3	30,580	20,480	1,720	65,000	29,920	960	23,800	14,280	920	25
H3 OR1	2,110	1,440	200	50,380	19,020	660	1,860	920	20	7
H3 OR2	2,460	283	7	13,260	2,080	160	1,920	60	0	20
H4 OR1	16,369	7,500	380	473,980	101,500	780	15,540	2,580	0	20
H4 OR2	2,780	1,880	160	15,040	5,500	140	1,960	800	40	13
H4 OR3	20,480	11,660	380	281,320	40,180	480	21,300	3,120	20	12

that when latex powdered gloves are used, the concentrations of airborne allergens are 10 times higher and the size of most airborne allergens is between 2.5 and 10 μ m.¹⁴

The present study refers to airborne particle concentrations without specifying which are from latex. This was not considered as a limitation as the air quality classification in clean rooms and ORs is defined on the basis of particle count. No threshold of airborne latex concentrations for sensitized patients has been established, although some authors suggest values between 0.6 and 10 ng/m³.^{26,27} Parameters of minimal levels of airborne contamination in the surgical area should therefore be determined.

Optimization of environmental factors: ventilation system, air-conditioning, air quality, and minimal use of latex-containing material as well as advances in technology and minimally invasive surgery, cleaning of the OR, hand hygiene after removal of gloves, staff transit restriction, and limiting the number of people in the OR contribute to a reduction in the concentration of airborne particles. The main objective of these measures is to minimize the risk of incidents.²⁸

Thorough cleaning of the surgical areas and the development of protocols established according to the Center For Disease Control are indispensable.²⁹ Cleaning staff should avoid using latex powdered gloves during cleaning of surgical areas before surgical intervention of latex-allergic patients.

Classification and the environmental parameters of each OR should be determined to schedule latex-allergic patients in surgical theaters that have the lowest levels of particles.

Some guidelines recommend a 30-minute interval after cleaning the OR before operating a latex-allergic patient. Theoretical studies have shown that 20 air changes/hour and 14 minutes ventilation achieve an efficacy of 99% in the extraction of contaminated air in a room; with 21 minutes ventilation, efficacy reaches 99.9%; incoming air should be 100% exterior.^{2,29,30} The lack of studies and protocols on this topic may account for the low implementation of 30-minute activity-free intervals.

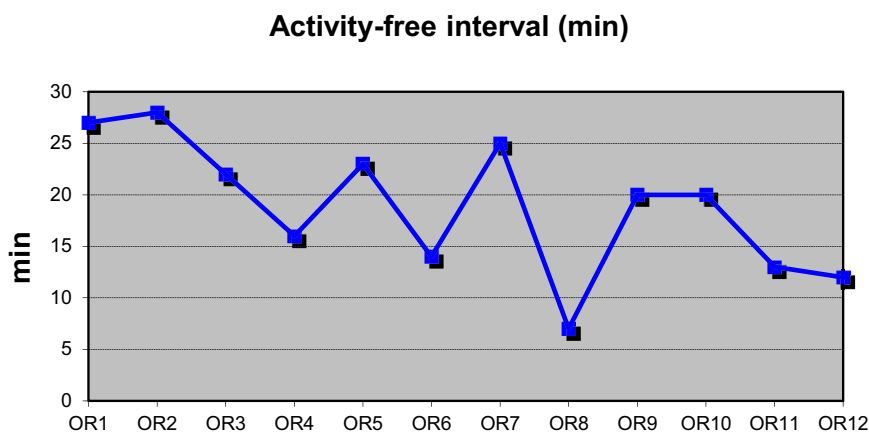


Figure 1. Recovery time in the different operating rooms. This figure is available in color online at www.jopan.org.

The application of this measure, according to the results obtained, would avoid alterations in the scheduling of surgical procedures and organizational inefficiencies in a setting that requires the optimization of resources.

Future research should focus on the importance of implementing a protocol of improved cleaning practice before a surgical session to reduce the number or airborne particles.

Conclusions

The present study shows that it is possible to operate latex-allergic patients between interventions if

the same environmental conditions found after a 15-hour activity-free interval can be replicated through thorough “end of session” cleaning, followed by a 32-minute activity-free interval and staff traffic restriction (no staff entry and exit). Other precautions such as material and medication should also be respected. Recovery of baseline particle levels cannot be achieved after cleaning between surgeries if activity-free interval and staff traffic restriction are not respected.

The conclusions reached in this study only apply to ORs that have the minimal structural facilities/ characteristics described: turbulent or laminar flow, classified as ISO 5, ISO 6, or ISO 7 according

Table 3. Statistical Significance of Differences Between Means

Description	Mean $\bar{X}$	<i>P</i> Value ($\alpha = 0.05$)	
Mean number of particles first thing in the morning before starting surgical session	10,689.75	<i>P</i> = .005	Significant difference
Versus Mean number of particles after cleaning between surgeries	62,710.83		
Mean number of particles first thing in the morning before starting surgical session	10,689.72	<i>P</i> = .164	Nonsignificant difference
Versus Mean number of particles after end of session cleaning + activity-free interval	5,368.5		
Mean number of particles after cleaning between surgeries	62,710.83	<i>P</i> = .0002	Significant difference
Versus Mean number of particles after end of session cleaning and + activity-free interval	5,358.50		

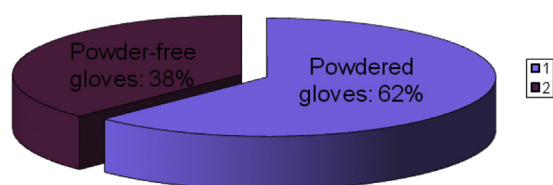


Figure 2. Types of gloves used. This figure is available in color online at www.jopan.org.

to ISO 14644-1:1999, an overpressure +10 Pa, a minimum of 20 air changes/hour, three stages of filtration, the last one closer to the OR should be an absolute filter.

Twelve-hour activity-free intervals are only reasonable in latex-allergic patients scheduled for elec-

tive surgery, as this does not cause any interference in the surgical session and does not affect productivity in the OR.

The application of a 32-minute interval would guarantee safe management of latex-allergic patients who require emergency surgery and scheduled patients with latex or crossed allergies not diagnosed until the moment of surgery.

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References

1. Association of Perioperative Registered Nurses. AORN latex guideline. *AORN J.* 2004;79:653-672.
2. Sleth J-C. Starting the day with latex-sensitised patients: Still up to date?. *Ann Fr Anesth Reanim.* 2011;30:764-765.
3. Bagur Marqués J, Duque González B. Allergy to latex in surgical ward (II). Nurses' operational protocol. *Rev Enferm.* 2009;32:195-202.
4. Blowers R, Crew B. Ventilation of operating-theatres. *J Hyg (Lond).* 1960;58:427-448.2.
5. Latex Allergy Committee. *Alergia al látex. Documento de Consenso.* Madrid, Spain: Sociedad Española de Alergología e Inmunología Clínica; 2012.
6. *Precaucions d'aïllament per evitar la transmissió d'agents infecciosos als centres sanitaris.* Barcelona: Government of Catalonia. Department of Health. Directorate General of Planning and Evaluation. Department of Public Health; 2009.
7. Centers for Disease Control (CDC). Recommendations for prevention of HIV transmission in health-care settings. *MMWR Morb Mortal Wkly Rep.* 1987;36(Suppl 2):1S-18S.
8. Merget R, van Kampen V, Sucker K, et al. The German experience 10 years after the latex allergy epidemic: Need for further preventive measures in healthcare employees with latex allergy. *Int Arch Occup Environ Health.* 2010;83:895-903.
9. Larese Filon F, Bochdanovits L, Capuzzo C, Cerchi R, Rui F. Ten years incidence of natural rubber latex sensitization and symptoms in a prospective cohort of health care workers using non-powdered latex gloves 2000-2009. *Int Arch Occup Environ Health.* 2014;87:463-469.
10. Galindo MJ, Quirce S, Garcia OL. Latex allergy in primary care providers. *J Investig Allergol Clin Immunol.* 2011;21:459-465.
11. Generalitat de Catalunya. Department of Health. *Informe sobre la conveniència de regular la utilització de guants de látex, als centres sanitaris de Catalunya.* Barcelona: Government of Catalonia. Department of Health. Directorate General of Planning and Evaluation. Department of Public Health; 2008.
12. Tarlo SM, Sussman G, Contala A, Swanson MC. Control of airborne latex by use of powder-free latex gloves. *J Allergy Clin Immunol.* 1994;93:985-989.
13. Heilman DK, Jones RT, Swanson MC, Yunginger JW. A prospective, controlled study showing that rubber gloves are the major contributor to latex aeroallergen levels in the operating room. *J Allergy Clin Immunol.* 1996;98:325-330.
14. Brown RH, Taenkhum K, Buckley TJ, Hamilton RG. Different latex aeroallergen size distributions between powdered surgical and examination gloves: Significance for environmental avoidance. *J Allergy Clin Immunol.* 2004;114:358-363.
15. Swanson MC, Bubak ME, Hunt LW, Yunginger JW, Warner MA, Reed CE. Quantification of occupational latex aeroallergens in a medical center. *J Allergy Clin Immunol.* 1994;94(3 Pt 1):445-451.
16. *Technical Committee AEN/CTN 171 indoor environmental quality. UNE 171340: Validación y cualificación de salas de ambiente controlado en hospitales.* Madrid: AENOR; 2012.
17. Boixareu Goma P, Borbón Ribera M, Garcia-Moreno Charlez E, et al. *Guía de buenas prácticas para la seguridad y la sostenibilidad del área quirúrgica.* Barcelona: Generalitat de Catalunya. Departament de Salut. CatSalut; 2012.
18. Humphreys H, Taylor EW. Operating theatre ventilation standards and the risk of postoperative infection. *J Hosp Infect.* 2002;50:85-90.
19. National Institute of Health. General secretary. *Guía Práctica para el diseño y mantenimiento de la climatización en quirófanos.* Madrid: Ministry of Health. National Institute of Health. Deputy General Directorate of Works, Services and Supplies; 1996.

20. AENOR. *UNE 100713: Instalaciones de acondicionamiento de aire en hospitales*. Madrid: Spanish Association for Standardization and Certification; 2005.
21. Andreu JM, Pallardó MA, Herranz A, Rodríguez JM, De Andrés JA. *Protocolo de adecuación hospitalaria al paciente alérgico al látex*. Valencia: Hospital General Universitario de Valencia; 2006.
22. Uribe Llopis P, Barbero Del Palacio P, Alonso Cobo MT, Bardón Fernández-Pacheco I, Caso Pita MC. Hacia un hospital sin látex. *Med Segur Trab*. 2008;54:99-108.
23. *Recomendaciones para la prevención y tratamiento de la alergia al látex*. Sevilla: Andalusian Health Service. Ministry of Health. Andalusian; 2004.
24. Hughes AB. Implementing AORN recommended practices for a safe environment of care. *AORN J*. 2013;98:153-166.
25. AENOR. *UNE-EN ISO 14644-1: Salas limpias y locales anexos. Parte 1: Clasificación de la limpieza del aire. (ISO 14644-1:1999)*. Madrid, Spain: Spanish Association for Standardization and Certification; 2000. Available at: <http://www.aenor.es/aenor/normas/normas/fichanorma.asp?tipo=N&codigo=N0022614#.VgPJajddp6Y>. Accessed September 24, 2015.
26. Baur X, Chen Z, Allmers H. Can a threshold limit value for natural rubber latex airborne allergens be defined? *J Allergy Clin Immunol*. 1998;101(1 Pt 1):24-27.
27. Swanson MC, Reed CE. *Measurement of occupational aeroallergens towards determination of permissible exposure limits*. New Orleans: Louisiana; 1996.
28. *Bloque Quirúrgico: Estándares y recomendaciones*. Madrid: Ministry of Health and Social Policy. 2010. Available at: http://www.msssi.gob.es/organizacion/sns/planCalidadSNS/docs/resumen_ejecutivo.htm. Accessed September 24, 2015.
29. Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care facilities, 1994. Centers for Disease Control and Prevention. *MMWR Recomm Rep*. 1994; 43:1-132.
30. Reines HD, Seifert PC. Patient safety: Latex allergy. *Surg Clin North Am*. 2005;85:1329-1340. xiv.