Journal of Infectious Diseases & Therapy
ISSN: 2332-0877

Yanagi, et al. J Infect Dis Ther 2021, 9:4

Short Communication Open Access

Actual Indoor Air Cleanliness for Surgical Site Infections during Thoracotomies and Endoscopic Surgeries

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Received date: July 02, 2021; **Accepted date:** July 16, 2021; **Published date:** July 23, 2021

Abstract

Previous studies based on simulations and mock-up experiments have reported the concentrations of fine particles and bacteria in ORs. However, the generation characteristics of fine particles and bacteria during actual surgery and their concentrations in ORs are not known. We identified the generation characteristics of airborne particles and bacteria in a Class 6 CR during endoscopic procedures and thoracotomies, and we report that the indoor airborne particulate concentration greatly exceeds the maximum allowable concentration established by the ISO 14644-1 standard. The findings strongly suggest how important it is to inhibit the development of pathogens for controlling SSIs during surgery.

Keywords: *In situ* measurements; Operating room; Surgical site infections; Particle; Bacterium; ISO; Air cleanliness

Abbreviations

CR: Clean Room; ETS: Electrosurgical Tool; ISO: International Standard; OR: Operating Room; SS: Surgical Smoke; SSI: Surgical Site Infection

Description

In 1900, the Dr. Joseph Rivière noticed that sparks from an electrode had coagulated areas of the skin of a patient, and he then went on to treat a cancerous ulcer on the hand of another patient. This is known as the first true use of electricity in surgery [1]. Typically, surgeons use ESTs. The use of various ESTs such as laser scalpels and ultrasonic surgical generators produce SS. SS contains compounds such as toxic gases (benzene, toluene and xylene), blood, bacteria, and viruses [2]. SS and microbes generated by medical personnel cause SSIs. The particle size range of surgical aerosols is 0.007 µm-0.42 µm for electric cautery, 0.1 µm-0.8 µm for laser scalpels, and 0.35 µm-6.5 µm for ultrasonic scalpels [3,4]. Controlling these fine particles is essential for preventing SSIs.

Simulations and mock-up experiments of indoor fine and microbial particle contamination in ORs have been conducted, and certain insights have been gained [5,6]. However, SS and microbial particles from medical personnel that are generated and dispersed during actual surgery are much more complicated, and they have not been reproduced faithfully in the simulations and mock-up experiments. When Yanagi et al., conducted *in situ* measurements of airborne particles and microorganisms that are generated during endoscopic surgery and thoracotomy in an ISO 14644-1 Class 6 OR, they found that the mean concentrations of airborne particles with sizes of ≥ 0.3 µm, ≥ 0.5 µm, and ≥ 1.0 µm during both endoscopic surgery and thoracotomy significantly exceeded the ISO 14644-1 standard [7]. The degree of air cleanliness of CRs, such as ORs, is defined in the ISO 14644-1 Classification of air cleanliness by particle concentration. This indicates the performance of a CR and does not take into consideration specific operational loads. In other words, this is the degree of air cleanliness without an operational load (Static environment). However, when CRs such as ORs are actually used, SS and fine and microbial particles from medical personnel are generated in the room (Dynamic environment). Thus, the indoor concentrations of airborne fine particles and bacteria increase significantly, vastly surpassing the ISO standard for air cleanliness.

Conclusion

The current ISO standard for CRs indicates their required performance, but does not guarantee the degree of air cleanliness when the room is in use. The concentration of airborne fine particles inside an OR during actual surgery far exceeds that specified in the ISO standard. To control SSIs during surgery, it is important to determine a means of controlling indoor SS and microbes produced by medical personnel.

Conflict of Interest

No conflict of interest.

Acknowledgement

This work was financially supported by JSPS (Japan Society for the Promotion of Science) (Grant number 20K21036).

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