Suspended Particulate Matter in an Office and Laser Smoke Particles in an Operating Room

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Abstract

Suspended particulate matter in an office and laser smoke particles in a laser operative room of the Otolaryngology Department, Ramathibodi Hospital were compared. Suspended particulate matter sizes of PM15, PM10 and PM2.5 were selected due to their impact on health. The amount and sizes of the particles were measured by a laser diode portable dust monitor. The mean and standard deviation were measured every hour for 6 periods and calculated by specific computer software. The amount of suspended particulate matters in the office were within the accepted safety level. The amount of suspended particulate matter including laser smoke particles in the operative room before, during and after each laser evaporative procedure was much higher than that of the office. The amount of suspended particulate matter was dangerous for all personnel in the operative room. Risk management for patients in the operative room should be stressed. The ventilation system of the operative room will be assessed further.

Key word: Suspended Particulate Matter, Laser Smoke Particle, Operative Room, Office Room, Laser Diode Portable Dust Monitor

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During laser evaporation in an operative room, laser smoke particles developed as suspended particulate matter in various sizes and amounts. The particle sizes of PM15, PM10 and PM2.5 were selected due to their impact on health (1,2). Recent experimental findings in animals and humans have indicated adverse respiratory effects from short-term exposure to particulate air pollutants, especially in sensitive subpopulations such as asthmatics(3). Motor vehicles and wood burning were significant sources of both PM2.5 and PM10 in most cities(4). The suspended particulate matter in an office was one indicator for the quality of indoor air(5). Personal exposure measurements and additional demographic and daily activity data are crucial for accurate evaluation of exposure to particles(6). Validated tools are needed to assess exposure most relevant to health. A laser diode portable dust monitor evaluated the amount and size of suspended particulate matter as a real time measurement. The laser diode portable dust monitor appears to be a useful tool for epidemiologic study that aims to examine the relationship between health outcome and personal exposure to peaks in suspended particulate matter(7). The association between daily mortality and air pollution depended on the pollutant or suspended particulate matter metric, the type of collection filter used, and location of the sampling (8,9). Measurement of laser smoke particles before, during and after each laser evaporative procedure were compared with that of suspended particulate matter in an office.

MATERIAL AND METHOD

The study was done in the Otolaryngology Department, Ramathibodi Hospital from May to October 2000. The real time analysis of the environmental EPA amount of the suspended particulate matter was PM15, PM 10 and PM 2.5 in mcg/m^3. A laser diode portable dust monitor (Series 1.104, Grim Labortechnik, Ainring, Germany) measured the suspended particulate matter continuously including laser smoke particle in the following situations (Fig. 1.):

1. In an office of the Otolaryngology Department during working hours:

1.1. In the morning : 06.00 - 07.00 a.m.

1.2. In the afternoon : 15.00 - 16.00 p.m.

2. In the Otolaryngology laser operative room during working hours but no operative cases were done on the day of the study. There was one air-conditioner and one exhaust fan. The suspended particulate matters in the operative room including the laser smoke particles created by a carbondioxide laser evaporator (Model 1060, Sharplan, Laser Industries Ltd., Tel Aviv, Israel) of a specimen put within a plastic box:

2.1. Pre-laser evaporation in the morning :10.00 - 11.00 a.m.

2.2. During-laser evaporation in the morning :11.00 - 12.00 a.m.

2.3. During-laser evaporation in the afternoon :13.00 - 14.00 p.m.

2.4. Post-laser evaporation in the afternoon :14.00 - 15.00 p.m.

Each period measurement was calculated by specific computer software to get the mean and standard deviation values.

RESULTS

Measurements of the amount and sizes of suspended particulate matter are shown from different periods and sites (Table 1). The amount of PM15, PM10 and PM2.5 are shown seperately in mean and standard deviation values. The amount of suspended particulate matter in the office prior to the morning working hours was not much different from the afternoon. The amount of suspended particulate matter before laser evaporation (OR pre-

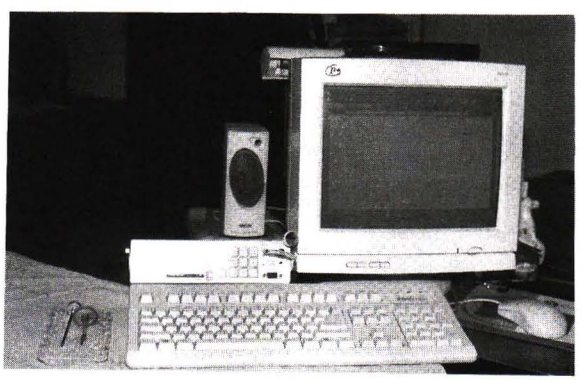

Fig. 1. Laser diode portable dust monitor with accessory to measure suspended particulate matters including laser smoke particles on the left ; computer with specific software for data analysis on the right.

Table 1. Suspended particulate matter amounts of PM15, PM10 and PM2.5 at various sites and times with and without laser evaporation.

Sites*	Time**	PM15***	PM10***	PM2.5***
1.1 Office	06.00-07.00 a.m.	9.6±12.3	5.0±1.8	2.1±0.3
1.2 Office	15.00-16.00 p.m.	17.5±9.4	7.3±7.8	1.2±0.5
2.1 OR pre-laser	10.00-11.00 a.m.	85.7±16.4	77.0±14.2	69.0±13.4
2.2 OR during-laser	11.00-12.00 a.m.	236.5±16.5	204.0± 8.0	111.0±13.0
2.3 OR during-laser	13.00-14.00 p.m.	306.3±14.0	246.3±18.2	227.7±14.8
2.4 OR post-laser	14.00-15.00 p.m.	189.4±12.1	183.6±12.1	172.8±11.3

* OR = operative room

** Each period of measurement was recorded continuously for one hour

*** PM 15, PM10 and PM2.5 were the suspended particulate matter sizes of less than 15, 10 and 2.5 micron respectively with amount in mcg/m^3

laser) used as the reference value in the operative room was higher than that of the office. Even after several working hours in the office, the amount of suspended particulate matter was still lower than that of OR pre-laser evaporation. The laser smoke particles during-laser evaporative procedures both in the morning and afternoon were much higher than that without laser evaporation. The amount of laser smoke particles after laser evaporation (OR post-laser) was residual laser smoke particles which were several times higher than that prior to the laser evaporation in the operative room.

DISCUSSION

In the office, there were six ventilating fans for the evacuation of suspended particulate matter. In the laser operative room, there was only one ventilating fan and the suspended particulate matter was recirculated in the room due to lack of a powerful exhaust system. The air ventilation system of the operative room should be evaluated further. Air exchange rates were found to be an important determinant of both indoor and personnel levels. The impact of indoor air quality on the health of patients and personnel in the operative room should be stressed[10,11]. The relationship between air pollution and asthmatic patients has mainly been determined using particulate matter measurements. Such effects depend on the particle size and concentration which can fluctuate daily at PM10 or PM2.5 levels [12]. The acute health effects of suspended particulate matter, even short-term low levels of exposure, increase the mortality and hospital admission rates of respiratory disease, fluctuations in the prevalence of bronchodilator use, cough and peak flow reductions, as well as long-term effects with respect to mortality and respiratory morbidity[13]. The relation between PM10 or PM2.5 exposure and acute health effects is linear at standard concentrations below 100 micrograms/m^3. A relatively low correlation between personal exposure and an ambient PM2.5 that is not improved by assigning exposure to the closest ambient monitor. The ambient monitors are able to capture the daily variations of indoor suspended particulate matter levels or even personal exposure and may help explain the robust association between ambient PM levels and health problems found in many epidemiological studies[14]. Higher personal exposures may be due to the proximity of individuals to particle sources, such as cooking and cleaning. The strength of personal-outdoor association for PM2.5 was strongly related to that for indoor and outdoor levels, suggesting that home characteristics and indoor particulate sources were key determinants of personal-outdoor association for PM2.5[15]. Whilst epidemiological studies have consistently demonstrated adverse effects of particulate matter exposure on human health, the mechanism is currently unclear. One of the major issues is whether the toxicity of the particles resides in some particular fraction of particles as defined by chemical composition or size[16]. There is evidence for still closer epidemiological association with sulfate ions, and experimental exposure-response studies suggest that the hydrogen ions and ultrafine (PM0.15) concentrations may be important risk factors[17]. Human lung parenchyma effectively retains PM2.5, suggesting the particles responsible for chronic particulate pollutant effects. Several different type/size classes of particles are

present in human parenchyma, but ultrafine particles make up only a small fraction of the total[17]. There are measurement artifacts in current methods used to measure ambient PM10 and PM2.5, including negative artifacts because of losses of sampled semi-volatile components (ammonium nitrate and some organics) and positive artifacts due to particle-bound water[18].

SUMMARY

Suspended particulate matter sizes of PM15, PM10 and PM2.5 were selected in this study due to their impact on human health. The amount and size of suspended particulate matter including laser smoke particles were measured by a laser diode portable dust monitor. In the office environment, the amount of all three particle sizes was within the safety margin.

The amount of suspended particulate matter including laser smoke particles in the operative room before, during and after laser evaporation was dangerous to the health of both patients and personnel in the operative room. The risk management for indoor air quality index should be evaluated.

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การเปรียบเทียบปริมาณของฝุ่นในห้องทำงานและฝุ่นจากการเผาไหม้เลเซอร์ในห้องผ่าตัด

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การศึกษาปริมาณของฝุ่นขนาดต่าง ๆ กันในห้องทำงานเปรียบเทียบกับปริมาณของฝุ่นที่เกิดจากการเผาไหม้ของเลเซอร์ในห้องผ่าตัด ณ ภาควิชาโสต นาสิก ลาริงซ์วิทยา คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี ผู้วิจัยได้เลือกวัดขนาดของฝุ่นที่เล็กกว่า 15, 10 และ 2.5 ไมครอน เนื่องจากมีผลกระทบต่อสุขภาพของคน โดยใช้เครื่องมือวัดฝุ่นชนิดเลเซอร์ไดโอดที่หิ้วได้เพื่อวัดทั้งปริมาณและขนาด การวัดทั้งหมด 6 ช่วงเวลา ๆ ละ 1 ชั่วโมง ซึ่งในแต่ละชั่วโมงจะทำการวัดอย่างต่อเนื่องกัน คำนวณค่าเฉลี่ยและค่าเบี่ยงเบนมาตรฐานด้วยซอฟแวร์เฉพาะในเครื่องคอมพิวเตอร์ ปริมาณของฝุ่นในห้องทำงานอยู่ในระดับที่ปลอดภัยซึ่งยอมรับได้ แต่ปริมาณฝุ่นในห้องผ่าตัดทั้งระยะเวลาก่อน ระหว่างและหลังการเกิดการเผาไหม้ของเลเซอร์มีปริมาณที่สูงกว่ามาก ซึ่งปริมาณที่พบอาจก่อให้เกิดอันตรายได้มากทั้งต่อบุคลากรและผู้ป่วย ความเสี่ยงนี้ควรได้รับการป้องกันโดยคำนึงถึงระบบระบายอากาศในห้องผ่าตัด

คำสำคัญ : ฝุ่น, ฝุ่นเลเซอร์, ห้องผ่าตัด, ห้องทำงาน, เครื่องตรวจวัดฝุ่นชนิดเลเซอร์ไดโอดซึ่งหิ้วได้

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