Air Quality Monitoring in a Neonatal Intensive Care Unit

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Air sampling in health care facilities, especially in special-care areas such as neonatal intensive care units (NICUs), should be done on a periodic basis in order to determine indoor air quality, efficacy of dust control measures, or air-handling system performance. (The draft guideline is available with the full text of this article at http://www.cdc.gov/ncidod/hip/enviro/env_guide_draft.pdf) (1). A practical method to assess air quality is to monitor airborne particles with in a certain size range using particle counters (2).

Airborne particles and wind speed were continuously monitored in an NICU with five beds from 0:00 to 18:00 on weekdays. The NICU was 199.6 m^3 in size (76.75 m^2 floor space by 2.6 m high), and equipped with an anteroom of 21.1 m^3 (8.1 m^2 floor space by 2.6 m high) and a fixed dusted room-air recirculation system with 85.4 % return. As shown in a sketch of the NICU (Fig. 1), four air-supply vents were located in the ceiling and fitted with high-efficiency particulate air (HEPA) filters for air cleaning. Two air-exhaust vents were located near the floor in two corners and three were located in the ceiling. The volume of air supply was 4,800 m^3/h, and the air changed 24 times per hour. In the room were seven incubators, including two spares, and five monitoring equipment units, respirators, a radiant warmer, several shelves for solutions, medical supplies, records, and other materials. Airborne particles of ≥ 1.0 μm diameter and wind speed were continuously monitored using a laser particle counter (KC-03A1, Rion Co., Tokyo) and a wind meter (6521, Kanomax Co., Tokyo) placed at different places in the room (point A, B, or C indicated in Fig. 1) 1 m above the floor. Point A was under an air-supply vent in the center of the room, point B was near an air-exhaust vent in a corner, and point C was near an air-exhaust vent in the ceiling and surrounded by an incubator, a monitoring equipment unit, and a sink unit.

The fluctuation in airborne particles in the NICU is shown in Fig. 2. At point A, the particle number was 10 - 80/ft^3 (4 - 30 $\times 10^2/m^3$) which was the lowest level among the three moni-

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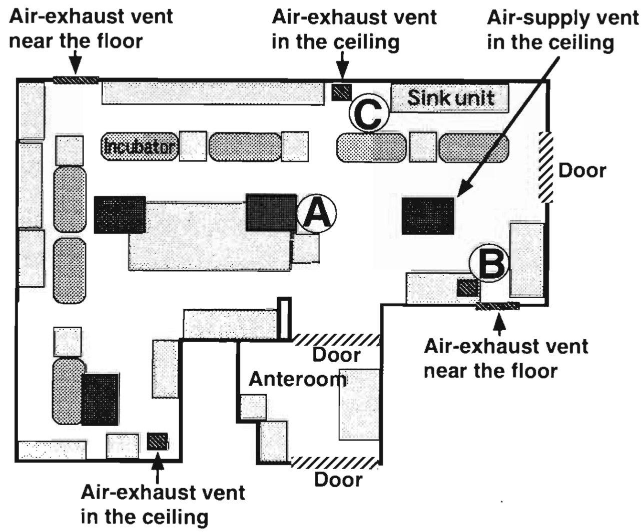

Fig. 1. Sketch of an NICU.

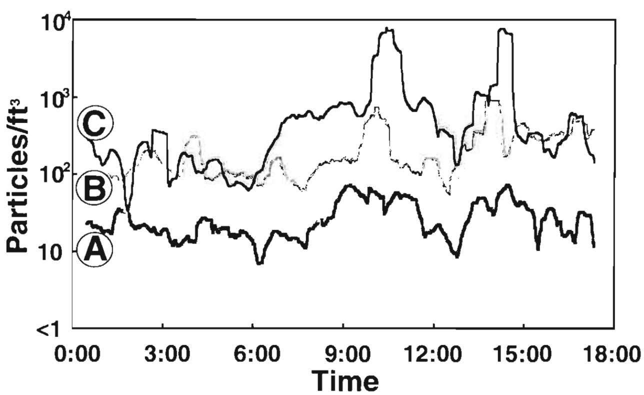

Fig. 2. Monitoring of airborne particles in an NICU. Airborne particles of >1.0 μm diameter were counted (averaged over 1 min periods) from 0:00 to 18:00. Each plot represents the average particle counts at intervals at point A, B, and C.

toring points, and the average and standard deviation was 28 $\pm$ 31/ft^3 (10 $\pm$ 11 $\times$ 10^2/m^3). Fluctuation of particle number was small relative to the other two points. At point B, the particle number was 0.7 - 10 $\times$ 10^2/ft^3 (2 - 40 $\times$ 10^3/m^3) with an average of 219 $\pm$ 428/ft^3 (7.67 $\pm$ 15.0 $\times$ 10^3/m^3). The particle number increased from 9:00 to 10:00 and 13:00 to 14:00. At point C, the particle number was in the range of 3 $\times$ 10 - 8 $\times$ 10^4/ft^3 (1 $\times$ 10^2 - 3 $\times$ 10^6/m^3) with an average of 874 $\pm$ 4,840/ft^3 (3.06 $\times$ 10^4 $\pm$ 16.9 $\times$ 10^3/m^3). The fluctuation pattern resembled that obtained at point B. At each of the monitoring points, particle number gradually increased after 6:00 and remained high during the day time with two peaks at 9:30-11:00 and 13:40-14:00. The average wind speed during the monitoring period was 0.33 m/s for point A, 0.08 m/s for point B, and 0.01 m/s for point C. The wind speed at point A was 33 times higher than that at point C.

These data indicated that airborne particles were effectively removed at points where the wind flow rate was high (point A), whereas near the air-exhaust vent (points B and C), the particle number was continuously high. In the latter two monitoring points, equipment and furniture obstructing wind flow may have contributed to the high particle score. Monitoring particles and air flow at various points in the room will be useful in deciding where to position the infants and other equipment. The proper design of NICUs will greatly reduce infection rates.

REFERENCES

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