Letters to the Editor

Aspergillus terreus During Hospital Renovation

To the Editor:

Multiple outbreaks of nosocomial aspergillosis have been described in the past two decades.[1] Immunocompromised hosts and environmental factors such as contaminated ventilation[2-5] and close proximity to renovation and construction sites[6-8] have been implicated in their pathogenesis.

In September 1991, four patients with respiratory cultures yielding *Aspergillus terreus* were identified in our hospital: two bone marrow transplant recipients, one patient with AML, and one with disseminated choriocarcinoma. Two patients had a single tracheal aspirate culture yield *A terreus;* both expired within one week thereafter. Both had pulmonary infiltrates, but only one had a postmortem examination and no aspergillosis was found. The remaining two patients had culture proven disease: pneumonia and aspergillosis in lung and brain diagnosed at autopsy.

All patients were housed in the intensive care unit (ICU), an eight-bed facility located on the sixth floor of the hospital, at the time of culture, death, or development of pneumonia. No other common hospital area, including radiology, was visited by all of the patients.

All ICU rooms are private and equipped with high-efficiency particulate air (HEPA) filtering with 8 to 12 air changes per hour. The patient rooms open to a common work area and are separated from the corridors and the main portion of the sixth floor by closed doorways (Figure). The unit was designed so that air pressure in patient rooms is positive in relation to surrounding spaces (except for two isolation rooms that are maintained at negative pressure), and the common work area is positive in relation to the corridors. The airflow path is designed to be unidirectional (air is supplied through a ceiling register above the patient's head and exhausted at floor level on the opposite side of the room).

Renovation on the two floors directly below the ICU, including removal of false ceilings and rerouting of ductwork, began in the first week of August 1991. Prior to the start of renovation, the southeast elevator was closed to patient transport. Floor-to-ceiling impervious barriers were constructed to separate patients and employees from renovation areas.

Because all four patients had been housed in the ICU, our initial investigation centered on air supply and flow in that area. Environmental studies performed included dioctyl phthalate (DOP) leak tests, smoke tests to monitor pressure gradients and airflow, and microbiologic air sampling.

The DOP test failed to detect any leaks >0.01% of the challenge DOP concentration, assuring the integrity of the HEPA-filtration system. However, it was noted that pressure in the ICU was negative in relation to the south hallway and the two nearby elevator shafts. When the building opened in 1975, pressure in the ICU had been positive in relation to surrounding areas. The change in this pressure gradient most likely occurred when a wall was built across the sixth floor during renovations in 1989. Opening the door in this wall reestablished positive pressure in the ICU.

It also was noted that patient room ventilation was conventional (air was supplied and exhausted from the ceiling) rather than unidirectional. This resulted in HEPA-filtered air circulating through the upper portion of rooms, with little benefit to the patients. Renovation of the ventilation systems in the ICU patient rooms was necessary to reestablish unidirectional airflow.

Environmental fungal cultures showed higher levels of aspergilli ($P = 0.04$, Kruskal-Wallis test) and fungi in the ICU during the investigation than before the outbreak or after corrective measures were undertaken. No other monitored patient care areas demonstrated similar increases.

Unfortunately, we were unable to isolate *A terreus* from the environment. However, the clustering of patients in the ICU and the proximity of ongoing renovation suggests a construction-related outbreak despite multiple precautions, including properly functioning HEPA-filtered air supply, appropriate dust barriers, and staff awareness.

HEPA-filtered air supply,

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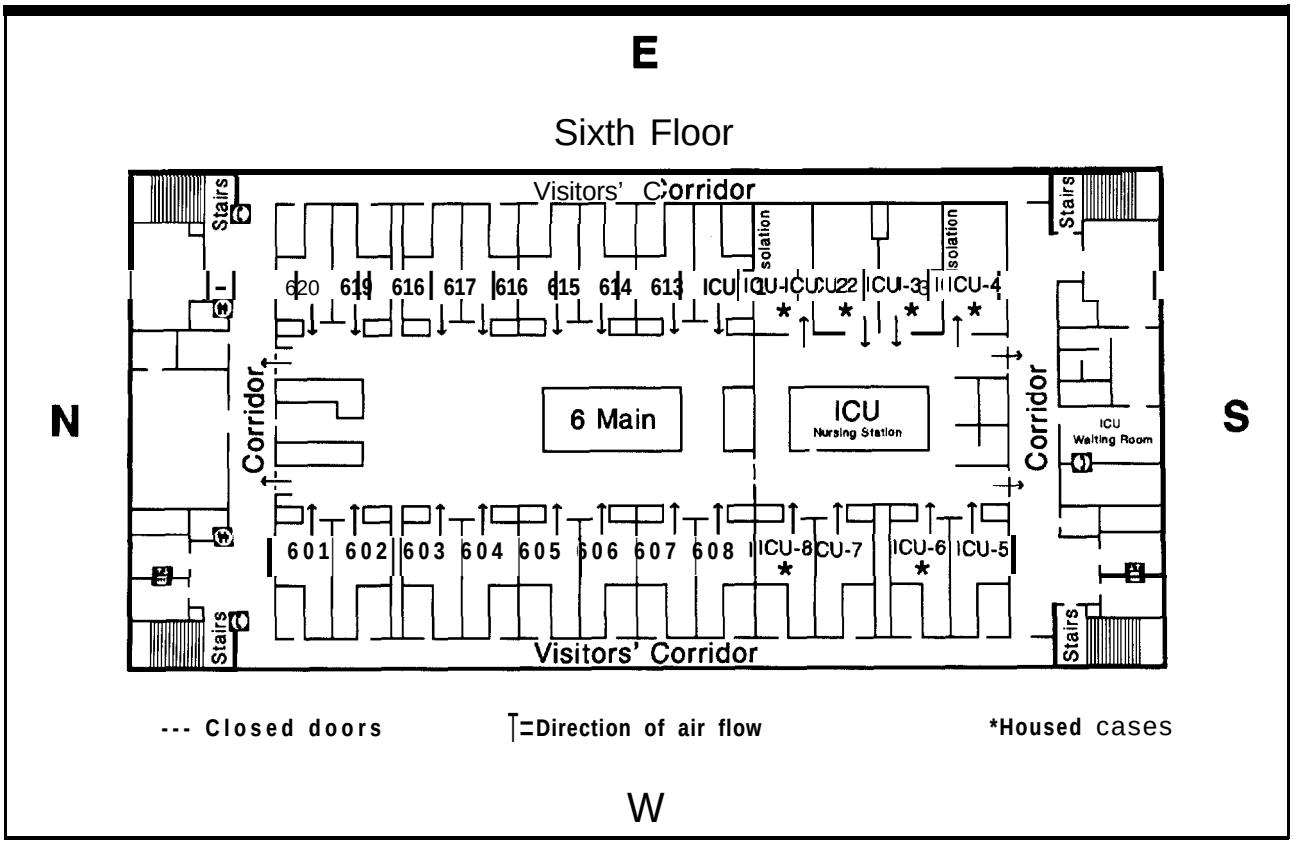

FIGURE. Floorplan of the sixth floor. Arrows denote pressure gradients.

alone or with horizontal laminar airflow, has been recommended to decrease exposure of immunocompromised patients to airborne fungal spores.[1,3,7] Despite the high efficiency of this system, several other outbreaks in units with HEPA-filtered air supplies have occurred.[2,5,8] Clearly, properly functioning HEPA-filtration systems alone are inadequate to prevent nosocomial aspergillosis.

We presume the reversed air-pressure gradient in the ICU allowed entry of fungal organisms from corridors, stairwells, and elevator shafts serving the ICU and renovation areas. The elevator shafts were believed to play the major role because they were the direct connection between renovation and patient care areas, and environmental sampling yielded large numbers of fungal spores ($>71/m^3$) but no *A terreus*. Although the reversed pressure gradient likely was established during the ICU renovation in 1989, we suspect the added burden of environmental fungal organisms from the renovation accounted for the outbreak. Walsh and Dixon[1] have recommended keeping construction areas with negative pressure relative to patient care areas. The current outbreak lends support to the importance of this recommendation. Once positive pressure was restored in the ICU, we noted a decrease in both total fungus and aspergillus spore counts.

Unidirectional airflow to the patients also was interrupted. It is likely that conventional ventilation increases the number of fungal spores reaching the patient from the floor. However, we believe that the reversal of air pressure gradients played the greater role because decreases in environmental spores were detected after gradient correction but before correction of unidirectional airflow.

After reestablishing positive pressure in the ICU but before completion of renovation, one additional patient with *A terreus* infection and one with colonization were identified (February 1992 and December 1991). No patient or environmental isolates have been detected in the past year.

In conclusion, meticulous monitoring of air filtration systems is necessary in institutions that house immunocompromised patients. Even in centers with HEPA filtration, other aspects of airflow, especially pressure gradients, must be monitored. *A terreus* should be included as a potential construction-related pathogen.

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Corrections

In the January article entitled "Electronic Surveillance of Antibiotic Exposure and Coded Discharge Diagnoses as Indicators of Postoperative Infection and Other Quality Assurance Measures" (1993;14:21-28), some citations to references were misnumbered. The citation to reference 13 in the second full paragraph of page 23 should have been to reference 12. The citation to reference 14 in the fourth paragraph of page 23 should have been to reference 13. Each citation to references 15 and 16 in the "Statistical Analysis" paragraph on page 24 should have been to references 14 and 15, respectively.

The second sentence of the paragraph entitled "Postoperative Antibiotics and Infection" on page 24 has been revised for clarity and now states, "When receiver operating curves were examined for the previously described subset of 317 patients, the threshold of at least two antibiotic days of parenteral postoperative antibiotics (with the first postoperative day excluded) gave the best combination of sensitivity and specificity: 93% and 91%, respectively."

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