Microbiologic Sampling of the Inanimate Environment in U.S. Hospitals, 1976–1977

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Data obtained in the first two phases of the Study on the Efficacy of Nosocomial Infection Control (SENIC Project) indicate that in 1975 three-quarters of U.S. hospitals performed environmental culturing on a routine basis; however, between 1970 and 1975, one-quarter had reduced the extent of environmental culturing permanently. Large hospitals (≥200 beds) and those with an infection control nurse who had completed a training course in hospital epidemiology were more likely to have reduced the extent of culturing. In 1976–1977 hospitals that performed such culturing collected an average of 500 environmental cultures per year, whereas larger hospitals and those with an infection control nurse collected significantly fewer cultures. Only 28 percent of the approximately two million environmental cultures collected in U.S. hospitals in 1975 were indicated by recommendations of the Centers for Disease Control and the American Hospital Association current at the time.

One approach to the surveillance and control of nosocomial infections that has been taken by a large number of U.S. hospitals is microbiologic sampling of the inanimate environment (i.e., environmental culturing). Although in the 1950s and 1960s this practice was widely recommended [1–8], in 1970 the Center for Disease Control (CDC) and the American Hospital Association (AHA) changed their recommendations and began advocating that hospitals discontinue most environmental culturing [9–11]. Since that time, only four indications for environmental culturing have been recommended: (1) routinely using spores to assure the effectiveness of various sterilization processes, (2) monitoring infant formulas prepared in the hospital, (3) checking for high levels of contamination on certain patient-care supplies (e.g., respiratory therapy or anesthesia equipment after disinfection and, more recently, dialysis fluids), and (4) judiciously culturing other environmental sources, when indicated in the investigation of a particular infection outbreak or other specific problems [8–17]. To evaluate the extent to which the older practices or the newer recommendations were being followed, we analyzed data from the first two phases of the Study on the Efficacy of Nosocomial Infection Control (SENIC Project) to determine the extent and nature of environmental culturing in U.S. hospitals.

METHODS

The information reported herein was collected in the first two phases of the SENIC Project [18]. In phase I, the Preliminary Screening Questionnaire Survey, we mailed a questionnaire to all U.S. hospitals in mid-1976 and received responses from 3,599 (86 percent) of those in the SENIC target population—all general medical and surgical hospitals that are short-term, are not Federal- or State-owned, have 50 beds or more and are located in the contiguous 48 states [19]. In phase II, the Hospital Interview Survey, personnel in 433 hospitals, constituting a representative sample of the SENIC target popu-

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TABLE I Relationship Between the Indications for and Extent of Environmental Culturing, 1975

Level of Environmental Culturing	Basis for Majority of Environmental Culturing: Routine	For Specific Problems	Total
Extensive	850 (33)	62 (7)	912 (26)
Moderate	1,418 (55)	336 (37)	1,754 (50)
Minimal	309 (12)	522 (57)	832 (24)
Total	2,577 (74)*	920 (26)*	3,498† (100)

NOTE: Nationwide results from the Preliminary Screening Questionnaire. From Haley and Shachtman [19], reproduced by permission.

* Except for these two row percentages, all numbers in parentheses are column percentages.

† 101 responding hospitals gave no answer to one or both of these questions.

lation, were interviewed between October 1976 and July 1977 to obtain more detailed information on their infection surveillance and control program activities; the information on environmental culturing was obtained from the interviews with the directors of the clinical microbiology laboratories. Although the phase I survey constituted a census of the target population of U.S. hospitals, estimates of environmental culturing practices nationwide were obtained from the phase II survey data by the statistical weighting procedures described elsewhere [20].

To determine whether the type of hospitals or the presence of an infection control nurse might have influenced the practice of environmental culturing, the information from both surveys was analyzed by the following major characteristics of hospitals: hospital size (seven categories based on the number of beds), affiliation with a medical school, geographic region (northeast, north central, south and west), type of ownership or control of the hospital (proprietary, nonprofit or owned by local government, e.g., city, county or hospital district), and the presence of an infection control nurse (or person with equivalent position). Information about the hospitals' characteristics was obtained from the AHA Annual Survey of Hospitals [21]. To study the relative strength of association of these characteristics (and their interactions) with measures of environmental culturing, we performed multivariate analyses using analysis of variance or the chi-square automatic interaction detection (CHAID) technique [22], as appropriate, without applying the sampling weights. The results of these analyses were then recalculated (e.g., by multiway cross-tabulation) using the sampling weights.

RESULTS

In the Preliminary Screening Questionnaire Survey, three quarters of the hospitals reported that in 1975 they performed the majority of environmental cultures on a routine basis, and one-quarter characterized their level of culturing as extensive. Hospitals that performed the majority of environmental cultures on a routine basis were more likely to be performing extensive environmental culturing; whereas, those that performed the cultures primarily for specific problems were more likely to be performing minimal culturing (**Table I**).

In the late 1960s and early 1970s, the percentage of hospitals that conducted routine environmental culturing increased steadily (**Figure 1**). By 1974, however, the trend had leveled off and had perhaps begun to drop in 1975; moreover, the percentage of hospitals that performed extensive culturing was no longer increasing. After 1970, the cumulative percentage of hospitals that reduced the extent of their environmental culturing increased substantially, and by 1975, 26 percent had reduced their level of culturing permanently.

In a multivariate analysis to determine what factors were associated with the hospitals' reduction of the extent of their environmental culturing, we found that a significantly higher percentage of hospitals with an infection control nurse who worked 20 hours or more per week had done so (34 percent), in comparison with hospitals that had no such infection control nurse (13 percent, $p < 0.0001$) (**Figure 2**). Furthermore, among the hospitals with no infection control nurse, the tendency to reduce the level of culturing was most strongly related to the size of the hospital: 28 percent of the larger hospitals reduced the level, 15 percent of the medium-sized hospitals and only 10 percent of the smallest hospitals ($p < 0.0001$); however, among hospitals with an infection control nurse, the most important factor appeared to be the infection control nurse's training: 41 percent of those hospitals whose infection control nurse had attended the CDC training course for infection control nurses had reduced their level of culturing, compared with 30 percent of the hospitals whose infection control nurse had attended only a non-CDC course, and only 19 percent of those whose infection control nurse had attended no training course ($p < 0.0001$).

From the responses in the Hospital Interview Survey in 1976–1977, we estimate that 73 percent of the hospitals cultured respiratory therapy (IPPB) equipment and 53 percent anesthesia equipment to monitor the adequacy of decontamination procedures—two routine culturing practices that were and are now recommended (**Figure 3**). Large numbers of hospitals still, however, routinely cultured to check operating room and other housekeeping procedures, and to monitor contamination of the air and of sterile products and other environmental items—all practices that were not recommended.

Estimating the total number of environmental cultures performed per year by the type or source of the culture, we found that almost three quarters of a million cultures were performed to check operating room clean-up and other housekeeping procedures (practices not recommended) in comparison with less than half a million cultures for the recommended practices of checking the adequacy of decontamination of certain patient-care

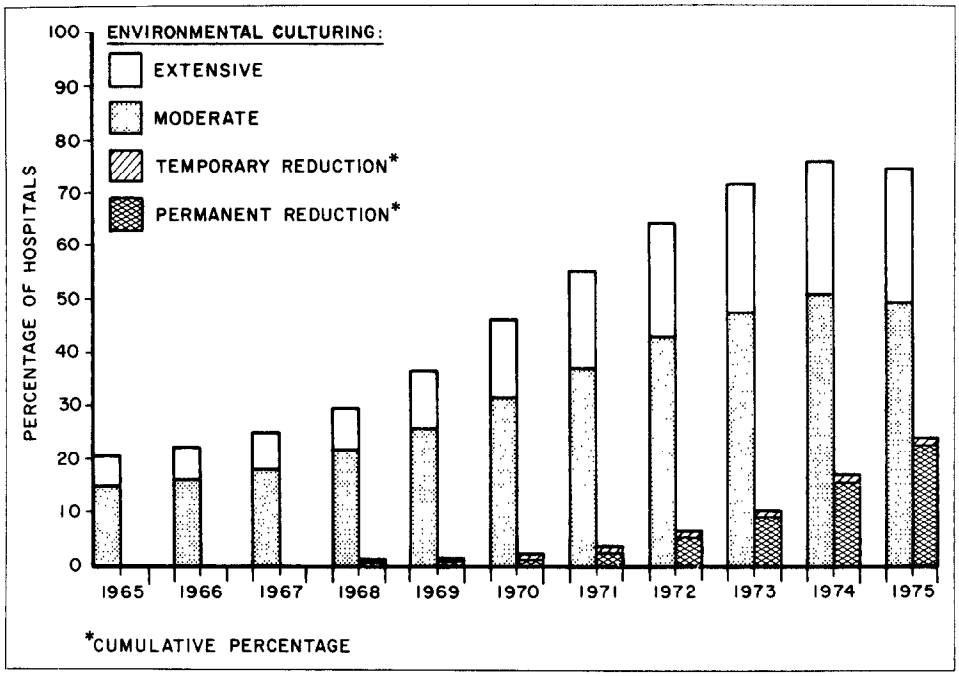

Figure 1. Levels of environmental culturing in 3,543 short-term general hospitals with ≥50 beds in the SENIC target population, 1965–1975. *Cumulative percentage. (Note: 56 responding hospitals did not answer this question.) From Haley and Shachtman [19]. Reprinted by permission.

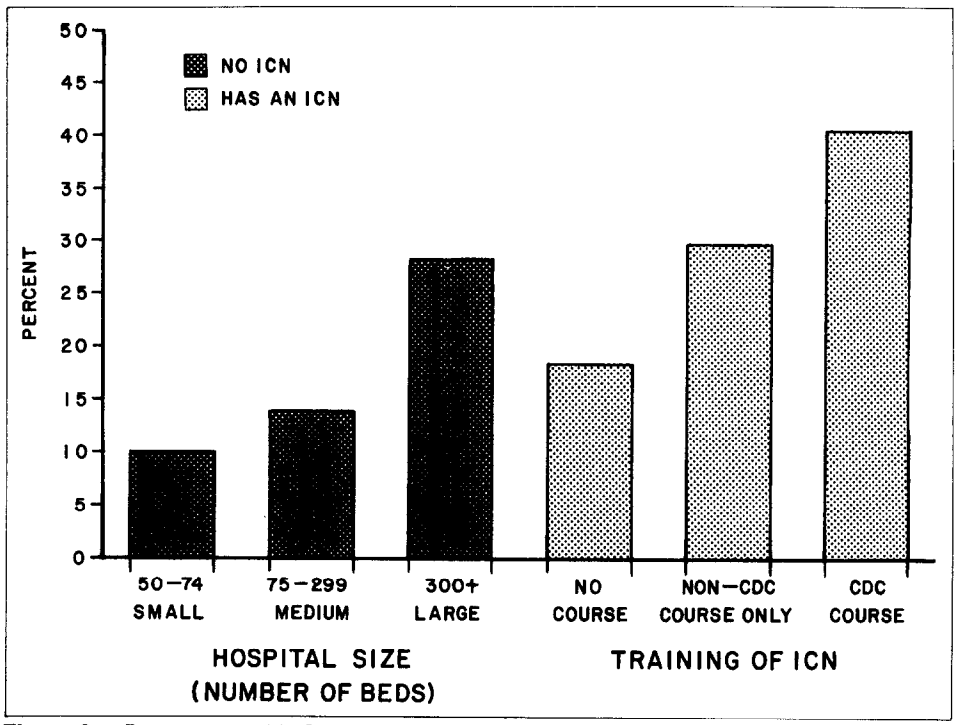

Figure 2. Percentage of U.S. hospitals that had reduced the extent of their environmental culturing activities between 1970 and 1975, by presence of an infection control nurse (ICN), infection control nurses training, and hospital size. (Note: 56 responding hospitals did not answer this question.)

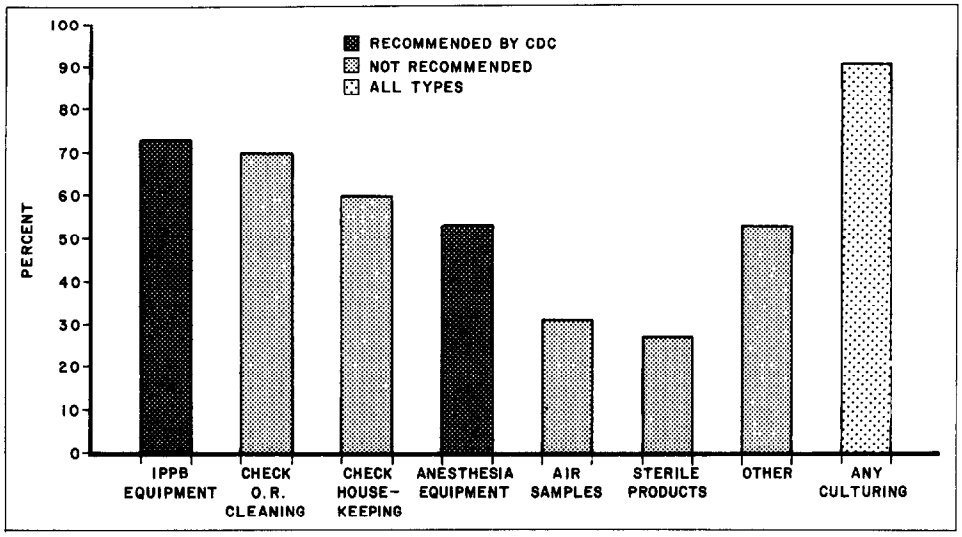

Figure 3. Estimated percentage of U.S. hospitals that perform environmental culturing, by type of culture, 1976–1977.

equipment (**Table II**). In all, we estimate that of the almost two million environmental cultures obtained nationwide in the year studied, only 28 percent were indicated by CDC and AHA recommendations current at that time.

According to the directors of the hospitals' microbiology laboratories, hospitals that carried out environmental culturing performed an average of about 500 environmental cultures of all types per year, and the maximum numbers of cultures obtained annually by some hospitals approached 5,000 (Table II). Evaluating the total number of cultures performed by each hospital per year in a multivariate analysis of variance, we found that hospitals with no infection control nurse tended to obtain far more routine cultures even when we controlled for hospital size ($p = 0.0005$); likewise, smaller

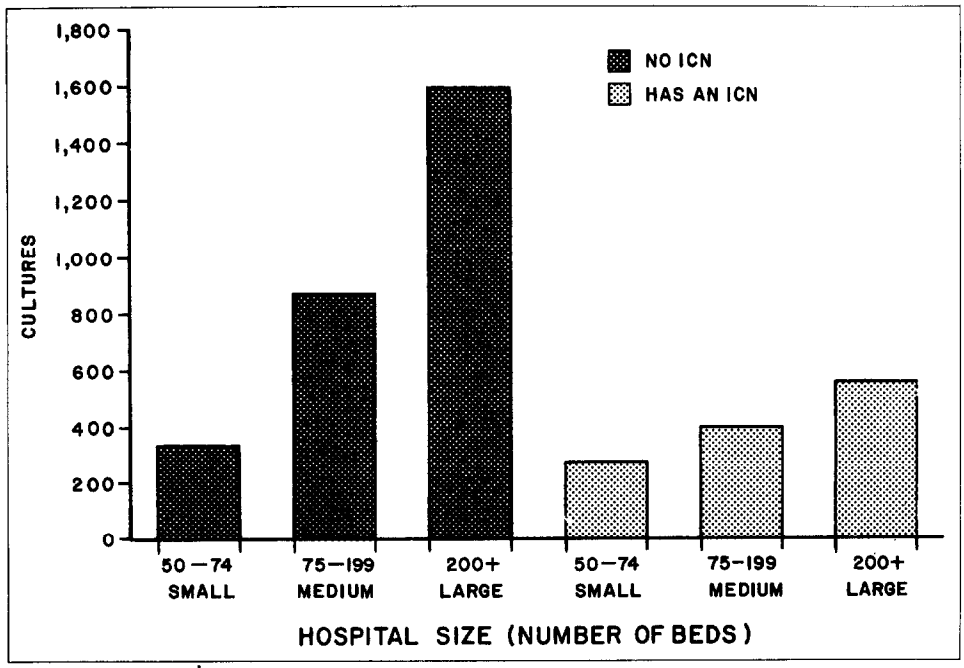

Figure 4. Estimated average total numbers of environmental cultures collected per year, by presence of an infection control nurse (ICN) and hospital size, 1976–1977.

TABLE II Estimated Numbers of Cultures of the Inanimate Environment Collected per Year in U.S. Hospitals by Type of Culture, 1976–1977*

Type of Culture	Number of Cultures Collected per Hospital† Mean (±SD)	Maximum	Nationwide
Surface culturing to monitor housekeeping procedures	191 (±7.1)	3,600	422,900
Surface culturing to monitor operating room clean-up	171 (±5.2)	1,680	373,600
Air samples	115 (+5.3)	840	270,000
Respiratory therapy equipment to monitor adequacy of decontamination	**114 (±2.7)**	**2,400**	**128,000**
Sterile products	108 (±4.7)	600	116,500
Anesthesia equipment to monitor adequacy of decontamination	**81 (±3.1)**	**1,200**	**95,000**
Other environmental sources	302 (±11.6)	3,600	534,600
All types of cultures	497 (±12.2)	4,860	1,940,600

NOTE: Boldface type indicates the types of cultures recommended by the CDC and AHA.
* Nationwide estimates from the Hospital Interview Survey.
† Includes only hospitals that collect one or more cultures of the specified type.

hospitals tended to obtain fewer cultures than larger hospitals ($p = 0.005$) (**Figure 4**).

COMMENTS

From our findings, we conclude that there were still large numbers of hospitals investing substantial resources in nonrecommended environmental culturing in 1976–1977. Assuming that the culturing materials and labor for obtaining and processing the cultures amounted to about $10.00 per culture (probably a conservative figure in view of recent inflationary increases), we estimate that in 1976–1977 U.S. hospitals were spending in the range of 20 million dollars per year for environmental culturing, about 15 million of which appears to have been spent on cultures that were not recommended.

By 1975, however, there were definite trends toward a reduction in such culturing practices. Although smaller hospitals were generally performing fewer environmental cultures, it appears that larger hospitals were ahead of smaller ones in reducing nonrecommended culturing. Also, infection control nurses, especially those who had sought training in infection control, appear to have led the way in this cost-saving movement. The importance of the infection control nurse's role seems especially convincing since it showed up strongly in both multivariate analyses, each using different measurements of the extent or reduction of environmental culturing, reported by different hospital personnel, and measured in different phases of the SENIC Project.

Although it is likely that these trends have continued and that nonrecommended environmental culturing is now practiced less extensively, the indications for and appropriate amounts of environmental culturing should continue to be stressed in training programs and continuing education sessions for infection control personnel and their colleagues in hospitals.

REFERENCES

1. Walter CW: Environmental sepsis. Mod Hosp 1958; 91: 69–78.
2. Kundsin RB: Bacteriological factors in hospital sanitation procedures. Modern Sanitation Building Maintenance 1960; 12: 20.
3. Walter CW, Kundsin RB: The floor as a reservoir of hospital infections. Surg Gynecol Obstet 1960; 111: 412–422.
4. Hall LB, Hartnett MJ: Measurement of the bacterial contamination on surfaces in hospitals. Public Health Reg 1964; 79: 1021–1024.
5. Fincher EL: Surface sampling application, methods, recommendations. In: Proceedings of the institute on control of infections in hospitals, University of Michigan, March 1-3, 1965. Ann Arbor: School of Public Health, University of Michigan. 1965; 189–199.
6. Pryor AK, Vesley D, Shaffer JG, Walter CW: Cooperative microbial surveys of surfaces in hospital patient rooms. Health Lab Sci 1967; 4: 153–159.
7. Fincher EL: Air sampling application, methods, recommendations. In: Proceedings of the Institute on Control of Infections in Hospitals, University of Michigan, March 1-3, 1965. Ann Arbor: School of Public Health, University of Michigan, 1965; 200–209.
8. Mallison CF: Monitoring of sterility and environmental sampling in programs for control of nosocomial infections. In: Cundy KR, Ball W, eds. Infection control in health care: microbiological surveillance. Baltimore: University Park Press. 1977; 23–31.
9. Eickhoff TC: Microbiological sampling. Hospitals 1970; 44: 86–87.
10. Center for Disease Control: Microbial environmental surveillance in the hospital. National Nosocomial Infections Study Report, Center for Disease Control, Atlanta, GA, June 1970.
11. American Hospital Association: Statement on microbiologic sampling in the hospital. Hospitals (Jan 1) 1974; 48: 125–126.
12. American Public Health Association: Environmental mi-

crobiologic sampling in the hospital. Health Lab Sci 1975; 12: 234–235.
13. Stamm WE, Mallison GF: More on control of nosocomial infection in hospitals. JAMA 1974; 230: 373.
14. Wehrle PF: More on control of nosocomial infection in hospitals. JAMA 1974; 230: 373.
15. Bartlett RC, Groschel DHM, Mackel DC, Mallison GF, Spaulding EH: Control of hospital associated infections. In: Manual Clin Microbiology 2nd ed. Washington, DC: American Society for Microbiology, 1974; Chapt 91.
16. Mallison GF: A hospital program for control of nosocomial infections. APIC Newsletter 1974; 2: 1.
17. von Graevenitz A, Pantelick E: Should potential sources of hospital-acquired infections be monitored? Infection (W. Germany) 1975; 3: 1–5.
18. Haley RW, Quade D, Freeman HE, Bennett JV, The CDC SENIC Planning Committee: Study on the efficacy of nosocomial infection control (SENIC Project) summary of study design. Am J Epidemiol 1980; 111: 472–485.
19. Haley RW, Shachtman RS: The emergence of infection surveillance and control programs in U.S. hospitals: an assessment, 1976. Am J Epidemiol 1980; 111: 574–591.
20. Quade D, Culver DH, Haley RW, et al.: The SENIC sampling process: Design for choosing hospitals and patients and results of sample selection. Am J Epidemiol 1980; 111: 486–502.
21. American Hospital Association: Guide to the health care field. Chicago: American Hospital Association, 1977.
22. Kass GV: An exploratory technique for investigating large quantities of categorical data. Appl Statist 1980; 29: 119–127.