The state of infection surveillance and control in Canadian acute care hospitals

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Background: Nosocomial infections and antibiotic-resistant pathogens cause significant morbidity, mortality, and economic costs. The infection surveillance and control resources and activities in Canadian acute care hospitals had not been assessed in 20 years.

Methods: In 2000, surveys were mailed to infection control programs in all Canadian hospitals with more than 80 acute care beds. The survey was modeled after the US Study on the Efficacy of Nosocomial Infection Control instrument, with new items dealing with resistant pathogens and computerization. Surveillance and control indices were calculated.

Results: One hundred seventy-two of 238 (72.3%) hospitals responded. In 42.1% of hospitals, there was fewer than 1 infection control practitioner per 250 beds. Just 60% of infection control programs had physicians or doctoral professionals with infection control training who provided services. The median surveillance index was 65.6/100, and the median control index was 60.5/100. Surgical site infection rates were reported to individual surgeons in only 36.8% of hospitals.

Conclusions: There were deficits in the identified components of effective infection control programs. Greater investment in resources is needed to meet recommended standards and thereby reduce morbidity, mortality, and expense associated with nosocomial infections and antibiotic-resistant pathogens. (Am J Infect Control 2003;31:266-73.)

Nosocomial infections and antibiotic-resistant pathogens cause significant morbidity, mortality, and economic costs.[1-3] Rates of methicillin-resistant *Staphylococcus aureus* (MRSA) have increased 10-fold in Canadian hospitals during the past decade.[4] Nosocomial infections are second only to medication errors in frequency among adverse events befalling hospitalized patients.[5-7] In the landmark Study on the Efficacy of Nosocomial Infection Control (SENIC), more than 80% of US hospitals completed a detailed infection control survey; 338 hospitals and 338,000 patient medical records were intensively studied.[8,9] The following 4 essential components of effective infection control programs were identified: 1 full-time equivalent (FTE) infection control practitioner (ICP) per 250 beds, a physician trained in infection control, intensive surveillance, and intensive control. It was estimated that one third of nosocomial infections could be prevented if hospitals instituted all 4 measures.[8,9] An expert panel[10] reviewed the evidence for resources necessary for effective hospital infection control programs and made level I recommendations (ie, strongly supported by clinical studies) for surveillance for nosocomial infections, thorough analysis to allow interventions, outbreak management, and appropriate ICP and physician/doctoral personnel staffing levels. Recent surveys of infection control programs in Quebec[11] and Ontario[12] found that acute care hospitals in those provinces had fewer ICPs than that recommended by SENIC and a recent Canadian expert panel[13] and that appropriate surveillance was not conducted by the majority of hospitals.[13]

The Canadian Nosocomial Infection Surveillance Program (CNISP) is a collaboration of the Canadian Hospital Epidemiology Committee—a committee of the Canadian Infectious Disease Society that is composed of 23 teaching hospitals and their infection control programs—and the Centre for Infectious Disease Prevention and Control, Health Canada. One goal of the CNISP is to provide data to be used in the development of national guidelines to reduce nosocomial infections. As part of this effort, we assessed the resources and activities directed toward the prevention and control of nosocomial infections in acute care hospitals across Canada.

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METHODS

In the fall of 2000, a survey was sent to infection control programs in the 238 acute care hospitals in Canada that were identified as having more than 80 acute care beds. A list of eligible hospitals was compiled from listings provided by CNISP, the Canadian Health Facilities Directory,[14] Surveillance Provinciale Des Infections Nosocomiales,[11] and the Community and Hospital Infection Control Association (CHICA) Canada. The survey was sent to the staff member most responsible for the infection control program and was to be completed for either the 1999 calendar or fiscal year. If 1 infection control program was responsible for more than 1 institution in a larger health organization, aggregated data were accepted if data for individual hospitals were not available. The survey package included a bilingual cover letter and survey. Advertisements in the *Canadian Journal of Infection Control* and on the CHICA-Canada Web site, memos to CHICA-Canada chapter presidents, reminder postcards, and a second mailing were used to optimize response.

Instrument

The survey was designed to assess personnel, laboratory, computer, and reference resources and surveillance and control activities of the infection control program (Table 1). The survey was modeled after the SENIC instrument, with the addition of new items dealing with resistant micro-organisms and computerization.[15] From the scores assigned to responses to the surveillance and control items, composite indices were calculated. Indices were adjusted for the number and qualifications of ICPs and physicians directly involved in the infection control program, as in SENIC.[15] Secretarial support was incorporated into the human resources adjustment factors. The surveillance and control indices were designed such that 0 (zero) indicated no effective surveillance and control activities were being performed and that 100 indicated all effective activities were being performed.[8,9] The questionnaire and index formulae can be viewed at the Kingston General Hospital, Infection Control Service, Web site at *www.path.queensu.ca/ic/rich.htm*.

Statistical analysis

Data were analyzed with use of StatView Version 5.0 (SAS Institute, Cary, NC). Descriptive statistics were predominately used to present the data. The effect of hospital size and teaching status on surveillance and control indices was tested with multivariate analysis of variance, and the conservative Scheffè F test was used for multiple comparisons.[16,17] The relationships of resources and surveillance and control indices were tested with Pearson correlation coefficients and with point biserial coefficients for dichotomous variables.[16,17]

Table 1. Items included in the resources for infection control in hospitals survey questionnaire

Hospital characteristics
Bed numbers and types
Services and numbers
Resources
ICPs
Time devoted to infection control and specific activities
Professional category
Certified by Certification Board of Infection Control
Physicians/doctoral professionals
Time devoted to infection control and specific activities
Qualifications
Secretarial support provided to infection control program
Laboratory
Access to daily reports on cultures
Surveillance cultures for evaluating possible outbreaks
Computerization
Computers used for tabulation of infection data and infection reports
Use of statistical software to analyze data collected
References
Infection control journals and texts
Internet access
Current Health Canada guidelines on preventing nosocomial infections
Surveillance/case finding of infections
Denominator data collected
Specific statistics collected
Infections on wards, units, or service
Infections involving particular anatomic sites or medical devices
Methicillin-resistant *Staphylococcus aureus* (MRSA)
Vancomycin-resistant enterococci (VRE)
Clostridium difficile
Surgical site infections calculated and reported to surgeons
Compared infection surveillance with benchmarks
Case-finding methods used to detect new cases of nosocomial infections
Infection control activities
Communicated hospital's infection data to patient care staff
Circulated scientific information on infection control to patient care staff
Infection control authority
Direct authority to close wards or units to further admissions
Direct authority to have patients placed in isolation
Infection control policies
Isolation precautions for patients with VRE
Isolation precautions for patients with MRSA
Insertion, maintenance, and changing of IVs, tubing, and solutions
Respiratory precautions for tuberculosis and other airborne infections
Aseptic insertion and maintenance of closed drainage of Foley catheters
Routine system for changing breathing circuits on patients undergoing ventilation
Isolation precautions for patients with diarrhea associated with *C difficile*
The indications, drug choices, timing, and duration of perioperative antibiotics

RESULTS

Respondent hospitals' characteristics

The response rate was 72.3%; 147 surveys were received, representing 172 of 238 eligible facilities. Fifteen surveys were received from larger health organizations that represented up to 4 eligible hospitals. Two surveys were not included in the analysis because of incomplete information.

Table 2. Distribution of infection control program–related activities of ICPs, physicians, and doctoral professionals

Infection control program-related activities	ICPs* Mean % (SD)	Physicians and doctoral professionals† Mean % (SD)
Surveillance	30.4 (14.1)	21.5 (21.5)
Teaching infection control to other staff	14.2 (7.8)	6.8 (8)
Writing or reviewing policies for infection control	11.6 (10.2)	12.6 (10.9)
Evaluation of products	5.4 (3.8)	2.5 (3.4)
Attending meetings	10.6 (6.6)	25.6 (21.1)
Regional infection control activities	6.3 (6.9)	6.6 (7.7)
Managing epidemics/ outbreaks	8 (6.9)	10.7 (10.3)
Other (specify)	13.7 (11.1) Consultations, construction, clerical, research	13.5 (16.2) Research, professional, and clinical consultations

*N = 217.
†N = 126.

Hospitals owned and/or operated by larger entities comprised 90 of 143 (62.9%) of the sample. One third of infection control programs, 45 of 138 (32.6%), had direct responsibility for more than 1 acute health care facility.

The mean number of acute care beds per hospital was 292.5 (SD = 237.6), with a range of 79 to 1978 and a median of 230. All respondent hospitals had surgical services, including the following: 98.6% offered general/gastrointestinal, 92.3% gynecologic, 92.3% urologic, 87.9% joint replacement, 28.6% neurosurgery, and 26.2% cardiac surgery. The mean number of overnight and day surgeries per 250 beds per year was 11,388.9 (SD = 5415.1), and the median was 10,264.4.

Human resources

The mean number of ICP FTEs per 250 beds was 1.1 (SD = 0.5), and the median was 1.04. There were fewer than 1 FTE ICP per 250 beds in 42.1% of hospitals, and 80% had fewer than 1 FTE ICP per 175 beds. Most ICPs were nurses (87.8%, 201 of 229), and 9.6% (22 of 229) were medical laboratory technologists. Only a little more than half of ICPs (55.5%, 127 of 229) were certified by the Certification Board of Infection Control. ICPs spent more time on surveillance (30.4%, SD = 14.1) than any other activity (Table 2).

Physician or doctoral professional services were not provided to infection control programs in 41 of 145 (28.3%) hospitals. Of hospitals with physician or doctoral involvement, 87 of the 104 (83.7%) hospitals had physicians with infectious disease or medical microbiology specialty qualifications and/or physicians and doctoral personnel with formal training in infection control. Eleven of 12 doctoral professionals were microbiologists. The following methods of remuneration were reported for 106 physicians and doctoral personnel: 57 (53.8%) received salary, 12 (11.3%) were paid in kind, and 37 (34.9%) received no remuneration. The mean number of physician/doctoral hours per 250 beds for hospitals with physician or doctoral involvement was 6.7 (SD = 8) hours per week, with a median of 3.9. Almost half of physician and doctoral time provided to infection control programs was spent attending meetings (25.6%, SD = 21.1) and engaging in surveillance activities (21.5%, SD = 21.5) (see Table 2).

Secretarial support for infection control was present in 100 of 145 (69%) hospitals. In hospitals with secretarial service, mean support was 9.1 (SD = 10.7) hours per week per 250 beds, with a median of 4.6.

Laboratory, computer, and reference resources

Almost all infection control programs (142 of 145, 97.9%) had access to microbiology laboratory services that provided daily reports on cultures, and the same number could get cultures performed for evaluating possible outbreaks.

ICPs used computers for tabulating infection data and preparing reports in 97 of 145 (66.9%) hospitals. Statistical or specialized infection control software was used by 57 of 145 (39.3%) hospitals.

The *Canadian Communicable Diseases Report* was the most common infection control related journal to which the hospitals subscribed (133 of 144, 92.4%), followed by the *American Journal Of Infection Control* (120 of 144, 82.8%) and *Morbidity and Mortality Weekly Reports* (108 of 144, 75%). Infection control staff members had access to at least 1 major infection control textbook in 96.5% of hospitals. A complete set of the current Health Canada guidelines on preventing nosocomial infections in acute care hospitals was held by only 80.4%. Access to the Internet was available in 93.8% of programs, and medical literature abstraction service was available in 95.2% of programs.

Surveillance activities and policies

The surveillance index was composed of 23 items related to the collection and dissemination of nosocomial infection and antibiotic-resistance data. The mean index score of 143 of 145 hospitals was 61.7/100 (SD = 18.5), and the median score was 65.6 (Fig 1).

Systematic surveillance activities were reported by 133 of 145 (91.7%) hospitals. In 101 of 144 (70.1%) hospitals, infection rates were calculated for particular anatomic sites or medical devices (eg, ventilator-associated pneumonia). Infection rates by individual wards, nursing units, or services were calculated by 93 of 144 (64.6%) hospi-

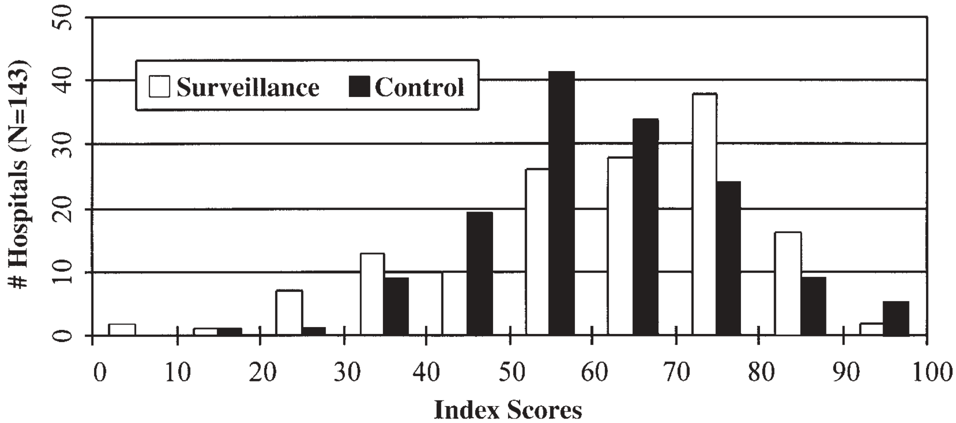

Fig 1. Distribution for surveillance and control indices.

tals. Specific infection rates were reported by 136 of 145 (93.8%) hospitals for MRSA, 121 of 145 (83.4%) for vancomycin-resistant enterococci (VRE), and 112 of 145 (77.2%) for diarrhea associated with *Clostridium difficile*.

Surgical site infection rates were calculated by 113 of 145 (77.9%) hospitals and after "clean" surgical procedures by 98 of 136 (72.1%). Infection rates were calculated by 104 of 144 (72.2%) hospitals after specific operations or surgical procedures. Infection rates were reported to the chief of surgery in 89 of 144 (61.8%) hospitals, and only 53 of 144 (36.8%) hospitals reported rates to individual surgeons.

Review of microbiology reports was the most commonly used case-finding method, and medical record chart abstraction was the least common method (Table 3). Only 83 of 139 (59.7%) hospitals compared their surveillance with published data or benchmarks.

Control activities and policies

The control index consisted of 44 items related to activities directed toward the reduction of nosocomial infections and patient colonization by resistant pathogens. The mean index score for 143 of 145 hospitals was 60.8/100 (SD = 14.6), with a median of 60.5 (see Fig 1).

Almost all hospitals (142 of 145, 97.9%) had infection control manuals. Programs for teaching and updating staff on infection control practices were present in 119 of 143 (83.2%) hospitals; however, only 34 of 145 (23.5%) had similar programs for medical staff. Attendance records were kept at 117 of 145 (80.1%) hospitals, and teaching effectiveness was monitored in 65 of 144 (45.1%). Infection surveillance data were routinely communicated to staff in 99 of 144 (68.8%) hospitals.

Policies regarding isolation precautions for patients with VRE existed in 99.3% of hospitals, MRSA in 98.6%, and diarrhea associated with *C difficile* in 80% (Table 4). Infection control had the direct authority to close a ward or unit to further admissions because of outbreaks in 96 of 144 (73.6%) hospitals and to have a patient placed in isolation in 141 of 145 (97.2%) hospitals.

The infection control program reviewed and approved policies developed in the employee health program related to the transmission of infections in 115 of 142 (81%) hospitals. During the last formal hospital accreditation, there was representation by the infection control program on accreditation teams/committees in 142 of 145 (97.9%) hospitals.

The effect of hospital size and teaching status on surveillance and control indices

Hospitals were divided into quartiles on the basis of the number of acute care beds. Surveillance scores were not influenced by hospital size (F = 0.5, P = .7). Hospital size had an effect on control index scores (F = 3.2, P = .03). The largest hospitals (377 to 1978 beds) had greater control scores than did the smallest (79 to 139 beds) (P = .0002), small to medium (142 to 228 beds) (P = .06), and medium to large hospitals (230 to 373 beds) (P = .02). Teaching hospitals had greater surveillance (F = 6.8, P = .01) and control scores (F = 4.2, P = .04) than did non-teaching hospitals.

Correlation of resources with surveillance and control indices

For correlations discussed in this section, the surveillance and control indices were not adjusted for human resources. The surveillance and control indices were correlated (r = 0.53, P < .0001). ICP complement and certification, computerization of surveillance functions, and reference materials were positively related to surveillance scores (Table 5). ICP certification, computerization, and references were positively related to control scores (see Table 5).

Table 3. Case-finding methods used in hospital surveillance

Case-finding method	Daily (%)	Weekly (%)	Monthly (%)	Quarterly (%)	Less than quarterly (%)
Microbiology reports reviewed by infection control staff (n = 145)	79.3	10.3	3.4	0.7	6.2
Charts of hospitalized patients reviewed by infection control staff (n = 145)	35.2	33.1	6.9	1.4	23.5
Hospitalized patients examined *and* charts reviewed by infection control staff (n = 145)	30.3	29	4.8	2.8	33.1
Infection control staff contact physicians or nurses for reports of new infections (n = 144)	19.4	27.1	6.3	3.5	43.8
Infection control report forms filled out by ward staff and sent to infection control staff (n = 144)	18.1	6.9	3.5	2.1	69.4
Discharged patients or their physicians contacted after discharge (n = 144)	6.9	2.8	9.7	3.5	77.1
Charts of discharged patients reviewed by infection control staff (n = 144)	6.3	27.8	27.1	5.6	33.3
Medical records provided number of infections discovered through chart abstraction (n = 145)	4.1	11	16.6	3.4	64.8

Table 4. Infection control policies in acute care hospitals

Policy	Is this a policy in your hospital? (% Yes)*	Is there a system to teach policy to patient care staff? (% Yes)*	Is there a system to monitor adherence to this policy? (% Yes)*	Do you think this policy is adhered to > 80% of the time? (% Yes)*
Isolation precautions for patients with VRE	99.3	89.6	75	91.0
Isolation precautions for patients with MRSA	98.6	92.3	72	90.2
Insertion, maintenance, and changing of IVs, tubing, and solutions	97.9	92.9	56.7	73.0
Respiratory precautions for tuberculosis and other airborne infections	95.8	90.5	74.5	91.2
Aseptic insertion and maintenance of closed drainage of Foley catheters	91.0	80.2	42.7	74.8
Routine system for changing breathing circuits on patients undergoing ventilation	87.3	83.1	61.3	87.1
Isolation precautions for patients with diarrhea associated with *C difficile*	80	83.6	61.2	83.6
Indications, drug choices, timing, and duration of perioperative antibiotics	45.8	56.9	50.8	67.7

*No. of "yes" responses/No. that responded.

DISCUSSION

This is the first comprehensive examination of the status of infection control programs in acute care hospitals in Canada in 20 years. The high response rate to this survey permits Canada wide generalizations to medium and large acute care hospitals.

Methodologic differences between earlier Canadian surveys and this survey hindered direct comparisons; however, some conclusions can be drawn.[18-20] In 1981, 88.1% of general hospitals with more than 99 beds and teaching hospitals engaged in surveillance, whereas in this survey, all but 1 respondent hospital engaged in surveillance.[18] ICP staffing levels in the 1980s were considerably less than that recommended by SENIC and 12% of acute care hospitals with more than 200 beds had no ICP.[18-20] Although there have been improvements in the interim and all hospitals in this survey have ICPs, 40% of infection control programs had fewer ICPs than that recommended by SENIC,[8,9] and 80% did not meet Canadian recommendations.[13] In our survey, 40% of Canadian hospitals did not have physicians or doctoral professionals with infection control training who provided service to the infection control program, yet this is viewed as a key requirement of infection control programs.[1,8,10] Expert panels have recommended secretarial services for infection control programs; however, only 69% of Canadian hospitals presently have such support.[10,13]

There also were significant computer and reference resource deficits. One third of infection control programs did not use computers to tabulate data and prepare reports, and a majority did not use statistical software, although these resources have been judged as being essential.[10] One fifth of programs did not have a com-

Table 5. Correlation of resources with surveillance and control indices

Hospital resources	*Surveillance index Correlation	*Surveillance index *P* value	*Control index Correlation	*Control index *P* value
ICP FTEs per 250 beds	0.20	.02	0.06	.5
% ICPs certified by Certification Board of Infection Control	0.25	.003	0.20	.02
Physician/doctoral professional hours per 250 beds	0.12	.2	0.11	.2
Physician/doctoral professional has infection control training	-0.002	.98	-0.02	.8
Secretarial hours per 250 beds	0.07	.4	0.03	.8
Computerization of data and statistical functions	0.24	.003	0.20	.01
Reference materials available	0.31	.0002	0.46	<.0001

*Not adjusted for human resources.

plete set of the current Health Canada guidelines on preventing nosocomial infections in acute care hospitals.

Intensive surveillance and intensive control activities were shown to be the most important factors in reducing nosocomial infections in the SENIC study.[8,9] Twenty-three percent of hospitals in our survey scored less than 50 on the surveillance index, indicating they were conducting fewer than half of recommended surveillance activities. Only 13% of hospitals conducted more than 80% of recommended surveillance activities. The figures were similar for control activities, with 21% of hospitals scoring less than 50 on the control index and only 10% conducting more than 80% of recommended control activities.

ICPs and physicians were found to be spending considerably less than the recommended 50% of their time devoted to infection control engaged in surveillance.[13] Surveillance was heavily based on microbiology reports, whereas active patient and device-related clinical surveillance that is more informative was used less frequently. In some centers, surveillance was ineffective because it was not being reported to staff: only two thirds of hospitals routinely communicated surveillance data to staff and only a third reported surgical site infection data to individual surgeons. It was found in SENIC that success in reducing surgical site infection rates required reporting the rates directly to surgeons.[8]

A limitation of this study is that the non-responding hospitals may have differed from our sample hospitals. It is possible that nonrespondents may have been unable to complete the comprehensive survey because of a lack of infection surveillance and control resources. This limitation may have resulted in an overestimation of resources available to hospitals for these activities and understated the extent of the deficits in infection surveillance and control resources that have been highlighted by this survey.

The attributable mortality of nosocomial infections in the United States was reported to be 80,000 deaths/year,[1] making nosocomial infections the fourth most common cause of death.[2] On the basis of US estimates[1] and the expected incidence of nosocomial infections and the number of hospital discharges in Canada, it can be expected that 220,000 occurrences of nosocomial infections resulting in excess of 8000 deaths occur in Canadian hospitals each year. Nosocomial infections in acute care hospitals are very costly, with a US total estimate of approximately $4 billion[1] and a British estimate of approximately 900 million pounds.[3] No published Canadian data or costs are available; however, the rapid rise of multidrug-resistant pathogens in Canada has added to the burden of nosocomial infections during the last 20 years.[4,21]

The deficits in infection control programs across Canada identified in this study call for health care planners, facility administrators, and regulators to take stock of the resources available in our hospitals to prevent nosocomial infections. Current estimates are that between 30% and 50% of nosocomial infections are preventable,[1,8,10,13] but to realize this level of prevention the resources must be put in place at each hospital. The cost benefit in terms of patient outcomes, morbidity, and mortality as well as direct and indirect economic costs are well established[22-25] and strongly support investments in infection control infrastructure.

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References

1. Haley RW, Culver DH, White JW, Morgan WM, Emori TG. The nationwide nosocomial infection rate. A new need for vital statistics. Am J Epidemiol 1985;121:159-67.
2. Jarvis WR. Selected aspects of the socioeconomic impact of nosocomial infections: morbidity, mortality, cost, and prevention. Infect Control Hosp Epidemiol 1996;17:552-7.
3. Plowman R, Graves N, Griffin MA, et al. The rate and cost of hospital-acquired infections occurring in patients admitted to selected specialties of a district general hospital in England and the national burden imposed. J Hosp Infect 2001;47:198-209.
4. Simor AE, Ofner-Agostini M, Bryce E, et al. The evolution of methicillin-resistant *Staphylococcus aureus* in Canadian hospitals: 5 years of national surveillance. CMAJ 2001;165:21-6.
5. Brennan TA, Leape LL, Laird NM, et al. Incidence of adverse events

and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. N Engl J Med 1991;324:370-6.
6. Leape LL, Brennan TA, Laird N, et al. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. N Engl J Med 1991;324:377-84.
7. Thomas EJ, Studdert DM, Burstin HR, et al. Incidence and types of adverse events and negligent care in Utah and Colorado. Med Care 2000;38:261-71.
8. Haley RW. Managing hospital infection control for cost-effectiveness: a strategy for reducing infectious complications. Chicago: American Hospital Publishing; 1986.
9. Haley RW, Culver DH, White JW, et al. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. Am J Epidemiol 1985;121:182-205.
10. Scheckler WE, Brimhall D, Buck AS, et al. Requirements for infrastructure and essential activities of infection control and epidemiology in hospitals: a consensus panel report. Society for Healthcare Epidemiology of America. Am J Infect Control 1998;26:47-60.
11. Frenette C, Meunier L, Moore D, Tremblay C, Le Groupe De Surveillance Provinciale Des Infections Nosocomiales (SPIN). Infection control resources and surveillance in acute care hospitals in Quebec. Toronto: Society for Healthcare Epidemiology of America Conference; April 2001.
12. Infection Control Subcommittee of Strategic Planning for Antimicrobial Resistance in Ontario. Infection control resources in hospitals in Ontario. Presented at: the CHICA Canada 2000 National Education Conference "The Sky Is the Limit"; May 2000; Toronto.
13. Health Canada, Division of Occupational and Nosocomial Infections. Development of a resource model for infection prevention and control programs in acute, long term, and home care settings: conference proceedings of the Infection Prevention and Control Alliance. Can J Infect Control 2001;35-9.
14. Rajan C, ed. Canadian health facilities directory. Don Mills, Ontario: Southam; 1998.
15. Haley RW, Shachtman RH. The emergence of infection surveillance and control programs in US hospitals: an assessment, 1976. Am J Epidemiol 1980;111:574-634.
16. Black TR. Doing quantitative research in the social sciences. Thousand Oaks (CA): Sage Publications; 1999.
17. Munro HM, Page EB. Statistical methods for health care research. Philadelphia: JB Lippincott; 1993.
18. Losos J, Trotman M. Infection control practices in Canadian hospitals. Am J Infect Control 1984;12:289-92.
19. Losos J, Trotman M, Campbell B. Profile of infection control practitioners in Canadian hospitals. Am J Infect Control 1984;12:325-8.
20. Campbell BA, McCunn SM, Trotman M, Wells GA. The infection control practitioner in Canadian hospitals with more than 200 beds. Am J Infect Control 1986;14:224-8.
21. Kim T, Oh PI, Simor AE. The economic impact of methicillin-resistant *Staphylococcus aureus* in Canadian hospitals. Infect Control Hosp Epidemiol 2001;22:99-104.
22. Wenzel RP. The Lowbury lecture. The economics of nosocomial infections. J Hosp Infect 1995;31:79-87.
23. Fraser VJ, Olsen MA. The business of health care epidemiology: creating a vision for service excellence. Am J Infect Control 2002;30:77-85.
24. Murphy DM, Alvarado CJ, Fawal H. The business of infection control and epidemiology. Am J Infect Control 2002;30:75-6.
25. Dunagan WC, Murphy DM, Hollenbeak CS, Miller SB. Making the business case for infection control: pitfalls and opportunities. Am J Infect Control 2002;30:86-92.

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COMMENTARY

Surveillance is a critical and essential element of any successful infection control program. In the 1980s, the Centers for Disease Control and Prevention's Study of the Efficacy of Nosocomial Infection Control (SENIC) definitively proved that active surveillance for nosocomial infections, when linked to prevention activities, reduces these infections. SENIC documented that the most effective infection control programs in the United States had: (1) at least 1 infection control professional per 250 beds; (2) physicians actively involved as directors of or participants in infection control programs; and (3) surgical site infection rates reported back to surgeons. A lot has changed in infection control since the SENIC study; responsibilities have increased as new pathogens and diseases have emerged—HIV and the blood-borne pathogen standard; antibiotic resistance, including multidrug-resistant *Mycobacterium tuberculosis*, vancomycin-resistant enterococci, and *Staphylococcus aureus*; Severe Acute Respiratory

Syndrome (SARS) caused by a new human coronavirus; transmission of exotic agents, such as West Nile virus, by blood product infusions or tissue transplantation, et cetera. With all of this, one would think that healthcare system infection control programs would be very robust and a prominent and major growing activity in our efforts to improve patient safety and healthcare outcomes. However, when one looks at the data rather than listens to the rhetoric, a disconnect seems to be in place.

The paper by Zoutman et al. unfortunately reflects the reality rather than the rhetoric. At Canadian acute care hospitals in 2000, more than 40% of hospitals had less than one infection control professional per 250 beds. Only about 60% of hospitals had a physician or doctoral professional involved in the infection control program. Even fewer (36.8%) report surgical site infection rates back to individual surgeons. The emergence and transmission of SARS was a wake-up call, telling us the importance of our infection control programs. Few interventions in medicine and public health have been definitively proven by appropriately designed studies to prevent disease; once such intervention is the nosocomial infection surveillance and prevention activities of our infection control programs. Furthermore, the impact of infection control programs, in terms of years of life saved, is greater than most other interventions or treatments we provide in medicine and public health. If prevention is primary and patient safety is important, as is commonly said, then we need to see the rhetoric followed by action. Our hospital administrators need to support their infection control programs (eg, financially, verbally, and with personnel), and our federal funding agencies need to back up the statements on prevention and patient safety with the financial resources to grow our infection control programs, so they have the capacity to maximally protect our patients (and healthcare workers) and improve patient outcomes. With billions of dollars going to research each year to find new cures, we (and our patients) need to demand that a small fraction of this amount go to implementing that which has been proven to prevent nosocomial infections: All hospitals should be required to have optimal infection control programs that implement all the evidence-based recommendations that have been proven to prevent infection.

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