

Recommended practices for surveillance: Association for Professionals in Infection Control and Epidemiology (APIC), Inc.

Terrie B. Lee, RN, MS, MPH, CIC, Ona G. Montgomery, RN, MSHA, CIC, James Marx, RN, MS, CIC, Russell N. Olmsted, MPH, CIC, and William E. Scheckler, MD

Surveillance in public health is defined as “the ongoing, systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health.”¹ Infection control professionals apply this definition to both reduce and prevent health care–associated infections (HAIs) and enhance patient safety. Surveillance, as part of infection prevention and control programs in health care facilities, contributes to meeting the program’s overall goals, namely: (1) protect the patient; (2) protect the health care worker, visitors, and others in the health care environment; and (3) accomplish the previous two goals in a timely, efficient, and cost-effective manner whenever possible.^{2,3}

The APIC first published its Recommended Practices for Surveillance in June 1998.⁴ This revision includes updates related to changing technology and methodologies, as well as new online resources. Demonstration of quality health care includes documentation of outcomes of care. Surveillance is a comprehensive method of measuring outcomes and related processes of care, analyzing the data, and providing information to members of the health care team to assist in improving those outcomes. Surveillance is an essential component of effective clinical programs designed to reduce

the frequency of adverse events such as infection or injury. Although the goal of contemporary infection prevention and control programs is to eliminate HAIs, epidemiologic surveillance is still required for accurate quantification of events and demonstration of performance improvement.

Although there is no single or “right” method of surveillance design or implementation, sound epidemiologic principles must form the foundation of effective systems and be understood by key participants in the surveillance program and supported by senior management. Teamwork and collaboration across the health care spectrum are important for the development of surveillance plans. Rather than institute a “one size fits all” approach to surveillance, each health care organization must tailor its surveillance systems to maximize resources by focusing on population characteristics, outcome priorities, and organizational objectives. To ensure quality of surveillance, the following elements must be incorporated:

- a. A written plan should serve as the foundation of any surveillance program. The plan should outline important goals, objectives, and elements of the surveillance process so that resources can be targeted appropriately. This is commonly integrated into a comprehensive infection control risk assessment process.
- b. Thoroughness or intensity of surveillance for an area of interest must be maintained at the same level over time. Fluctuations of a surveillance rate have no meaning unless the same level of data collection is maintained. External rate comparisons are not helpful and potentially misleading unless the systems used have comparable intensity.
- c. All the elements of surveillance should be used with consistency over time; this includes application of surveillance definitions and rate calculation methods.

From Department of Epidemiology, Charleston Area Medical Center, Charleston, West Virginia.

Address Correspondence to Terrie B. Lee, RN, MS, MPH, CIC, Director, Epidemiology & Employee Health, Charleston Area Medical Center, 3200 MacCorkle Avenue, Charleston, WV 25304. E-mail: tleewv@msn.com.

Am J Infect Control 2007;35:427-40.

0196-6553/\$32.00

Copyright © 2007 by the Association for Professionals in Infection Control and Epidemiology, Inc.

doi:10.1016/j.ajic.2007.07.002

- d. Personnel resources need to be appropriate for the type of surveillance being performed; this includes trained professionals who understand epidemiology and surveillance and who have access to continuing professional education opportunities.
- e. Other resources essential to surveillance include computer support, information and technology services, clerical services, and administrative understanding and support to maintain a quality program. The use of special infection control software, or self-formatted spreadsheets or databases can greatly facilitate many aspects of the surveillance process, including compiling and management of data, statistical analysis (eg, trend and comparative analysis, stratification, significance testing), graphical presentation, and report generation.
- f. The surveillance program (including surveillance processes and data), as part of the overall infection prevention and control program, should be evaluated at least annually. Evaluation methods may include qualitative assessments, but should also be based on quantitative changes (eg, improvements or decline in rates). Discontinuing surveillance of outcomes and/or processes that have remained stable and essentially unchanged over time should be considered to allocate resources to address risks with higher priority.

This document is intended to assist professionals who plan and conduct surveillance programs as well as those who assure that there is appropriate organizational support to accomplish appropriate surveillance. Although design of surveillance systems must be unique for each organization, incorporation of these seven core Recommended Practices for Surveillance provides a scientific framework to approach surveillance programs. In addition, expertise in surveillance methodologies will assist the infection prevention and control professional when addressing issues related to systems that perform inter-facility comparisons. (eg, public reporting of health care outcomes or other aggregate databases.)

The purpose of this document is to provide a framework for the development of epidemiologic-based surveillance systems for use in health care settings; it is not intended as an independent educational or training document. The following recommendations are based on a synthesis of current experience and knowledge of surveillance, as well as publications in peer-reviewed journals.

Surveillance planning may not always proceed in the sequential order presented here. However, organizations should ensure that all of the following practices are incorporated into each surveillance plan. These Recommended Practices for Surveillance have been most thoroughly applied to HAIs, but they are appropriate for any health care outcome or process.

RECOMMENDED PRACTICE I

Assessing the population

Each organization serves different types of patients who are at varied risks for health outcomes (both negative and positive). Development of surveillance systems should be based on evaluation of the populations of interest. Such a risk assessment is critical so that resources can be targeted at populations who are at risk for the outcomes of greatest importance. This, in turn, enables clinicians to use surveillance information to enhance and improve care provided to those targeted populations.

Practical applications

1. Obtain information to describe and understand population characteristics. The following questions may assist in the assessment of a patient population:
 - What types of patients do we serve?
 - What are the most common diagnoses?
 - What are our most frequently performed surgical or other invasive procedures?
 - Which services or treatments are used most frequently?
 - Are there services or treatments that increase risk of infection for the patient?
 - What types of patients increase liability and/or costs for the organization?
 - Does the organization's strategic plan focus on particular groups of patients?
 - What types of health concerns exist in the community, region, or regulatory environment?
 - Which patients are at increased risk for infection or other important outcome?

Though not addressed here, a general knowledge of risk factors for infection and other outcomes is essential. Such information should be obtained from the literature and other training sources. Similar assessment questions should be formulated for surveillance of other organizational subpopulations such as health care workers.

2. As appropriate, use organization-specific sources to obtain population information. Sources might include the following:
 - Medical records
 - Financial services
 - Information services
 - Quality/utilization management
 - Surgical database
 - Administrative/management reports
 - Risk management
 - Public health reports
 - Community agencies
 - Occupational/employee health

- Human resources records
 - Marketing reports
3. Conduct population risk assessment in conjunction with selecting the outcome or process (see “Selecting the outcome or process for surveillance” section below) to establish priorities for surveillance.

Examples

1. Hospital A is a 1500-bed tertiary care medical center offering a wide range of inpatient and outpatient services. There are six critical care units (medical, surgical, coronary, neurosurgical, pediatrics, and neonatal). The open heart surgery program is one of the largest in the country. There is a large orthopedic surgery program and a predominant gynecology service as well. An analysis of surgical procedures data from the operating room database reveals that coronary artery bypass graft (CABG) procedures, orthopedic joint replacements, and hysterectomies are among the most commonly performed surgical procedures. Outpatient medical records indicate that primary care is available in the clinic setting, with large numbers of participants in both the pediatrics and geriatrics populations.
2. Hospital B is a 75-bed acute care hospital in a rural setting. Medical records show that most admissions are adult patients with a variety of acute medical diagnoses. General surgical procedures are performed by the two staff surgeons, with cholecystectomies, hysterectomies, and hernia repairs the most frequently performed. Some nursing personnel have reported that many patients may have had indwelling urinary catheters longer than necessary or without a clear indication for use. One health problem noted by the local public health department is a recent increase in the incidence of tuberculosis (TB).
3. A home health agency provides care to a wide range of patients, specializing in intravascular access/treatment with short-term and long-term central lines and with peripheral lines. There is also a large number of patients with indwelling urinary catheters.

RECOMMENDED PRACTICE II

Selecting the outcome or process for surveillance

An organization would rarely find it feasible to conduct organization-wide surveillance for all events. A logical method for setting surveillance priorities and associated resource allocation is essential. The choice of outcomes or processes to be measured defines the surveillance that is appropriate for each measure. An outcome is the result of care or performance. Outcomes may be negative (eg, infection, injury, increased length

of stay) or positive (eg, patient satisfaction). A process is the series of steps taken to achieve an outcome (eg, immunization, use of patient restraints, compliance with policies associated with a given outcome). Outcomes and processes included in a surveillance plan should be those that have the most important relevance to the population served. This selection process should occur in conjunction with population assessment (see “Assessing the population” section above). Decisions may be based on morbidity, mortality, cost, or other parameters. Legislative, regulatory, or accrediting organizations as well as corporate or network entities may have additional requirements for surveillance activities that may affect the relative priority of surveillance objectives.

Practical applications

1. Select outcomes or associated processes for surveillance based on organizational and patient population risk assessment. Consider the following:
 - Relative frequency of the event
 - Cost or impact of the negative outcome, such as treatment costs, length of stay, functional status, quality of life, mortality, severity measures, and litigation and/or public relations risks
 - Potential for surveillance information to contribute to prevention activities
 - Customer needs (eg, priorities set by the health care team)
 - Community served (eg, health needs of the patient population)
 - Organizational mission and strategic goals
 - Strength of association between process and important outcome
 - Microbiology data and/or antimicrobial use findings
 - Regulatory or accrediting body requirements
2. Allocate surveillance resources by directing them toward highest ranked priorities.
3. Re-evaluate resulting surveillance objectives as needed, at least annually.

Examples

1. The following infection surveillance is planned for a calendar year at Hospital A (see Example 1 in “Assessing the population” section above):
 - All patients in the intensive care unit will be monitored for two types of device-associated infections, ventilator-associated pneumonias (VAPs), and central line-associated bloodstream infections (CLABSIs). Rationale: high-risk patients, substantial opportunity for improvement, can compare with rates most recently reported by the National Nosocomial Infections Surveillance/National Healthcare

Safety Network (NNIS/NHSN) of the Centers for Disease Control and Prevention (CDC).

- Adherence by personnel with “bundles” (groups of evidence-based interventions) for prevention of VAPs and CLABSIs will be monitored. Rationale: processes that are associated with prevention of infectious outcomes.
 - Surgical site infection (SSI) surveillance will be performed on the three most common types of surgical procedures: CABG, orthopedic joint replacements, and hysterectomies. Rationale: CABG: high-risk patients, potential for serious adverse outcomes, frequently occurring procedure, risk management concerns; joint replacements: same rationale; hysterectomies: frequently occurring procedure. Rates for comparison are available from NHSN. Also, nurses have reported a perception that there have been numerous surgical site infections in patients undergoing hysterectomy.
 - Antibiotic prophylaxis will be monitored as a process measure among the same surgical populations, with a focus on antibiotic delivery timing. Rationale: process known to be associated with preventing the outcome of SSI.
 - Immunization rates will be monitored in the inpatient settings and outpatient medical and pediatrics clinics. For pediatrics, state-required childhood immunizations will be included. For adults, the focus will be on influenza and pneumococcus vaccinations among high-risk populations. Rationale: process that is known to prevent serious infections, required information for primary care monitoring as well as a quality indicator for the Centers for Medicare and Medicaid Services.
2. The annual infection surveillance plan for Hospital B (see Example 2 in “Assessing the population” section above) will include the following components:
- SSI surveillance will be performed for cholecystectomies, hysterectomies, and hernia repairs. Because the number of procedures is so low, rate calculations may be needed only annually or perhaps less frequently. Although the infection control professional (ICP) will keep aware of SSIs, there is no plan to calculate infection rates for other types of infections, because infections occur too infrequently and the numbers are too small to be meaningful. Rationale: focus on the most frequent surgical procedures, can compare rates to those reported by CDC’s NNIS/NHSN system.
 - TB skin-testing compliance rates will be monitored among all staff, as well as among patients in high-risk populations. Skin test conversion rates will also be followed among staff. Rationale:

increased prevalence of TB in community, opportunity for early detection and intervention.

- Use of indwelling urinary catheters will be monitored among all patients. Rationale: process associated with infectious outcome.
 - Immunization of appropriate patient care personnel for hepatitis B will be monitored, as will annual influenza vaccination participation rate. Rationale: processes known to prevent serious infections.
3. A home health company (see Example 3 in “Assessing the population” section above) decides to include three types of device-associated infections in the annual surveillance plan: central line-associated bloodstream infections, peripheral line-associated bloodstream infections, and catheter-associated urinary tract infections. Patients with intravascular devices will also be monitored for development of phlebitis. Rationale: potential for improvement of high-risk device-related outcomes.

RECOMMENDED PRACTICE III

Using surveillance definitions

In any surveillance system, all data elements should be clearly defined. This includes the outcome or process, “at-risk” population, and risk factors. Valid definitions will enhance consistency, accuracy, and reproducibility of surveillance information.

Practical applications

1. Use standardized written case definitions to ensure precise surveillance. Where available and applicable, use previously published, validated definitions. These may be obtained from federal agencies, regulatory bodies, and professional organizations. Where not available, prepare written definitions to ensure intra-organization standardization. For accurate and valid comparisons of data, use the same definitions over time.
2. When historical data are used for internal comparisons or for external comparisons, ensure that the same definitions are used for outcomes and processes and that populations are at similar risk.
3. If definitions are changed, be aware that such changes compromise the comparability of rates over time. This information should be highlighted when reporting data to avoid misinterpretation.

Examples

1. The ICP at an acute care hospital decides to conduct surveillance for primary bloodstream infections associated with the use of central lines in the surgical intensive care unit (SICU) patients. To be able to

compare findings to the most recent CDC NHSN data, she uses the CDC case definition^{5,6} for primary bloodstream infections. Patients eligible for this surveillance are defined as adult patients in the SICU with one or more central intravascular catheters.

2. The ICP at a long-term acute care (LTAC) facility decides to conduct surveillance for primary bloodstream infections associated with the use of central lines in the population they serve. Eligible patients for this surveillance are defined as those admitted to the LTAC with a central intravascular catheter. She uses the published long-term care definitions⁷ for primary blood infections.
3. The risk manager of a large corporate health network wants to conduct surveillance for “preventable accidents due to unsafe conditions” at 40 company-owned ambulatory care clinics. He finds that there are no published definitions for accidents. He decides to restrict monitoring to include only falls and automobile collisions. He writes case definitions for use in all facilities as follows:

- A fall is defined as a sudden, unexpected change in position in which a person comes to rest unintentionally on the floor and/or on some object, which occurs on corporate property. Falls will include incidents in which the person is found lying on the floor and/or on some object and is unable to account for his or her position. Falls will not include incidents in which a patient is eased to the floor by someone who had been assisting the patient. Falls will be divided into three categories, depending on severity: (1) no visible or apparent injury; (2) minor injury, including pain or bruising; or (3) serious injury requiring follow-up x-ray films, sutures, or immediate medical evaluation.
- An automobile collision is defined as any automobile colliding with another car, pedestrian, cyclist, or permanent structure, on or within a 50-foot radius of the property.

The surveillance definitions will be applied to all occurrences among clinic patients, visitors, employees, or volunteers in the network.

4. The National Clinical Services Manager of a dialysis center network wishes to compare infection rates between their 23 centers as well as to an external database. The company’s Infection Control consultant recommends collecting data consistent with the Dialysis Incident Event component of the NHSN Patient Safety Component Protocol. Local access infection was defined as: pus, redness, or swelling of the vascular access site and access-associated bacteremia was not present and patient was hospitalized or had initiation of an intravenous antimicrobial agent. Access-associated bacteremia was defined as blood

culture positive with source identified as the vascular access site or unknown. Patient-months was selected as the denominator. The number of chronic hemodialysis patients with each access type who received hemodialysis at the center during the first two working days of the month was used to estimate the number of patient-months. A worksheet with all the defined components was completed by the quality management coordinator at each site for cases meeting infection criteria. The respective center’s data management clerk was responsible to tabulate dialysis days and compute estimated patient-months.

RECOMMENDED PRACTICE IV

Collecting surveillance data

The process of collecting surveillance data should be managed by knowledgeable professionals qualified by training and experience. Surveillance personnel require access to appropriate information sources to consistently apply methods and thoroughly record data.

Practical applications

1. Train personnel and others in data collection methods specific to each surveillance objective. Data collectors can include infection control or other professionals as well as staff with interest or participation responsibilities. Whenever possible, oversight of the surveillance program should be by an ICP who is certified in infection control and epidemiology (CIC).⁸
2. Collaborate with available information technology resources to support surveillance activities and consider performing data collection off-site, when knowledgeable infection control personnel are not available on-site.
3. Develop the data collection tool to fit a given surveillance objective, and after the necessary data elements are determined. Limit collection to what is needed for the specific surveillance objective. Forms for data collection could include intranet-based, computerized data entry screens, handheld personal digital assistant devices, and/or paper forms.
4. Consider commercially available software to filter large amounts of data to improve productivity of personnel. Access to a broad range of information such as patient clinical data, pharmacy, radiology, and laboratory is increasingly becoming available electronically in many health settings and can enhance the efficiency of surveillance.
5. Support and be involved in efforts to introduce and maintain an electronic health record (EHR). Participate in planning the development of automated and semi-automated reports, to ensure that key

data elements are captured and retrievable for epidemiologically meaningful analysis (eg, device days for calculation of device-associated infection incidence density rate).

6. Be aware that passively obtained data may be biased (eg, incomplete because of underreporting). Carefully analyze and interpret data that are exclusively derived through passive surveillance, where reports are initiated by the caregivers and must be prompted by recognition of the need to report the occurrence of an event (eg, reporting of medication errors, patient falls, occupational injuries).
7. Determine the appropriate approach to surveillance (ie, concurrent [prospective] and/or retrospective, depending on the issue being surveyed and available resources). Concurrent surveillance is initiated when the patient is still under the care of the organization. Advantages include the ability to capture the information in real time, interview the patient's caregivers, and interactively obtain or observe findings that may not be recorded in the patient record. Concurrent surveillance may be more costly and may have limited sensitivity if there is delay in completion of the patient record, such as with late laboratory results. These data may be incomplete. Retrospective surveillance involves primarily closed record review and the examination of information after the patient has been discharged or is no longer under the care of the organization. Although it does not permit interactions with ongoing caregivers, it allows for a comprehensive review of sequential events in the closed record and avoids the often time-consuming efforts of locating and reviewing charts in busy patient care areas. This efficiency associated with retrospective review is especially attractive if there is little opportunity or need for intervention. Consider the impact of delays in the coding process when collecting data that rely on coding, such as ICD-9.
8. Avoid singular reliance on "easily retrievable" data such as that derived from administrative datasets like abstracted billing information. There is growing evidence that such use significantly compromises the quality and accuracy of these for surveillance of HAIs.⁹⁻¹² Administrative data may be useful for identifying possible HAIs, but they are not reliable or valid for epidemiologic purposes.
9. Incorporate postdischarge surveillance for certain outcomes, particularly when important information may become apparent after the patient leaves the health care organization (eg, surgical site infections, certain adverse drug reactions). If included, the strategy for postdischarge surveillance should be clearly outlined in the surveillance plan. Note, because there remains no consensus on efficacy or validity

of various postdischarge surveillance methods, data derived from this component should be identified with appropriate notation should there be pressure for inter-facility comparison of performance.

10. Collect data from a variety of sources. Use information technology resources where available. Sources for data collection may include:
 - Administrative databases
 - Patient chart/records (inpatient and outpatient sources)
 - Communication with caregivers
 - Ancillary service reports (eg, laboratory, pharmacy, radiology, risk management)
 - Admission diagnoses reports
 - Surgical schedule/databases
11. Consider the development of standardized training methods for staff involved in data collection. Training for those merely responsible for denominator collection might be as simple as one-to-one instruction or review in a staff meeting. For staff responsible to apply infection surveillance definitions, or perform detailed risk factor collection, more formal education is indicated. In-person workshop-type training with practice cases to classify and receive feedback could be presented. Other approaches particularly useful for multiple or remote geographic locations might include self-study modules with practice cases, Web-based sessions, or conference calls.

Examples

1. An acute care hospital is conducting surveillance for device-associated infection rates and device utilization ratios in its SICU. The team meets to develop the surveillance plan. The ICP will monitor and collect data for primary bloodstream infections associated with central lines and VAPs. The respiratory therapy department will use its automated database to generate the number of SICU patients on a ventilator at the same designated time each day. The SICU nursing staff will collect and record the number of patients with a central line each day. The Patient Accounts representative will provide the count of patient days (data already collected for other purposes).
2. Because urinary tract infections are associated with the use of indwelling catheters, a home health agency has decided to conduct process surveillance of appropriateness of catheter usage. Data collection will be limited to the first month of admission for each new patient. Nurses gather the data regarding patients with catheters and approved indications for catheter use during their visits.
3. A freestanding ambulatory and short-stay surgical hospital, identifies selected operations for active surveillance of SSI. The ICP collects elements

Box 1. Terms of numerical measurement

Ratio	A general term, obtained by dividing one number by another. The numerator and denominator do not have to be related.
Proportion	A ratio in which the numerator must be included in the denominator. Often expressed as a percentage. The numerator represents a part of the whole (the denominator).
Rate	A ratio with a particular relationship between the numerator and the denominator, where the denominator includes time measurement. Term often loosely applied generically to all numerical measurements.
Crude rate	Overall rate for an entire population or organization. Difficult to interpret because of the likely differences between subgroups in the overall population.
Category-specific rate	A rate calculated for a subpopulation so that comparisons will be possible.
Incidence	A proportion. A measurement of new cases of disease within a population over a given period. The numerator is the number of new cases of the event being measured and the denominator is the initial population eligible or "at risk" to develop the condition or event. Also known as cumulative incidence.
Incidence density	Also known as incident rate. Uses a denominator of person-time units, or time units of exposure to account for variation in the periods that each person is at risk for the event being measured (numerator).
Prevalence	A type of proportion; a measurement of existing cases of disease within a population over a given period of time.

necessary for risk stratification from review of operative records every Monday, Wednesday, and Friday. Educational programs on the importance of postdischarge infection reporting and on the CDC NHSN definitions of SSI are conducted for the surgeons, clinical, and office staff. Additionally, the ICP offers telephone courtesy consultations on infection control issues to physicians' offices. Each month, a questionnaire is sent to designated contact persons in each surgeon's office. Included in the mailing is a list of patients who underwent the selected operations, dates of surgery, and a request to provide date of postoperative visit and to identify whether or not an infection was present. A return envelope is included. The ICP also makes brief telephone calls to the offices on a rotating schedule to assure SSI reporting is still in process and to check on other infection control needs.

- An acute care hospital has implemented an electronic health record. Information Technology has built reports for the Infection Prevention and Control Department. Data on central line days in the intensive care unit are now fully automated and can be requested on demand for any time period. Microbiology reports are processed through a commercially available software program that combs through the laboratory information system. The ICP evaluates the information to confirm that the positive blood cultures in intensive care patients with central lines truly meet the most recently published NHSN definitions of infection.

RECOMMENDED PRACTICE V**Calculating and analyzing surveillance rates**

Surveillance information is usually expressed in numerical measurements of the outcome or process being observed. Ratios, proportions, and rates (Box 1) are frequently used for these expressions, although they are commonly (and hereafter in this document) generically referred to as "rates."

Table 1. Crude procedure-specific SSI rate

Number of CABG operations	Number of SSIs	Rate (%) (number of SSI ÷ number of CABG × 100)
122	2	1.6

It is essential that appropriate calculations be performed and reported with a consistency of methodology over time for interpretation of each surveillance component. Consistency includes the concept of thoroughness of case finding (surveillance intensity) and accuracy of the case and population definitions. Analysis and comparison of rates within an institution over time and across institutions also require that all aspects of surveillance be equivalent.

Practical applications

- To optimally support the surveillance process, identify appropriate and feasible types of rates for a surveillance component prior to data collection.
- Recognize that rates (rates, ratios, and proportions) are fractions. The numerator is the event of interest. The denominator is a measurement of the population in which the event may occur.
- Present rates in a manner that is understandable to those who need to use the information.
- Be aware that a rate can be accurate and consistent but still not useful or interpretable if the numerator is too small (infrequent event) or the denominator is of inappropriate size (usually too small). In some instances, less frequent calculation of rates may allow for accumulation of sufficient numbers.
- Use statistical probability methods to determine whether apparent differences in rates are meaningful.

Examples

See examples in "Applying risk stratification methodology" section below.

Table 2. Ventilator-associated pneumonia rate

Number of ventilator days in pediatric ICU	Number of ventilator-associated pneumonias in pediatric ICU	Rate per 1000 ventilator days (number of ventilator-associated pneumonias ÷ number of ventilator days × 1000)
801	5	6.2

Table 3. Peritoneal dialysis-related peritonitis

Total peritoneal dialysis months (total cumulative months all patients received dialysis during specified time period)	Number of peritonitis cases	Rate per 1000 dialysis months (number of peritonitis ÷ total dialysis months × 1000)
989	11	11.1

Table 4. Immunization rate

Total persons eligible for pneumococcal vaccine in HMO target population	Total who have been immunized (number actually accepting vaccination)	Immunization rate (%) (total immunized ÷ total eligible × 100)
9050	7569	83.6

Outcome measures

1. SSI rate (proportion) (Table 1).
2. Ventilator-associated pneumonia rate (category-specific or device-specific incidence density) (Table 2).
3. Peritoneal dialysis-related peritonitis (category-specific or device-specific incidence density) (Table 3).

Process measures

1. Immunization rate (proportion) (Table 4).
2. Surgical antibiotic prophylaxis timing (proportion)
 - Prophylaxis cases: specified procedures for which prophylaxis is indicated, excluding contaminated and dirty/infected cases.
 - Adherence: first dose given within 1 hour before incision (Table 5).
3. Device utilization ratio (DUR) (ratio). See examples in “Applying risk stratification methodology” below.
4. Compliance with group of validated care processes known to prevent infection (ie, “bundle”) (proportion) (Table 6).
5. Patients with indwelling urinary catheters in whom there is an appropriate indication for presence of the device (proportion) (Table 7).

RECOMMENDED PRACTICE VI

Applying risk stratification methodology

Within a population under study, there is frequently lack of homogeneity. This may be from differences in age, sex, severity of underlying illnesses, or other factors. Such differences require that the population be subdivided into groups with like characteristics. This

adjustment is usually called stratification. Without stratification, internal comparisons of rates over time or external comparisons are likely to be invalid or misleading.

Practical applications

1. Apply risk stratification methods to achieve the following:
 - Allow meaningful and accurate comparisons to be made.
 - Foster understanding and acceptance by recipients of the data.
 - Facilitate utility and validity of interventions.
2. Determine current availability of risk stratification methods.
 - Determine to what extent the methods have been validated.
 - Ascertain if relevant stratification methods are recommended by key organizations (eg, a composite risk score for surgical site infections used for NHSN or a severity of illness index).
 - If no validated methods are available for analysis and interpretation, obtain epidemiologic and/or biostatistical assistance. For some rates, risk stratification may not be possible.
3. If rates are stratified, assure that subpopulation sizes are large enough to be statistically meaningful.

Examples

See also examples in “Calculating and Analyzing Surveillance Rates” section above.

Table 5. Surgical antibiotic prophylaxis timing

Number of specified procedures for which antibiotic prophylaxis is indicated (eg, CABG)	Number receiving prophylaxis within 1 hour before incision	Adherence rate (%) (number receiving prophylaxis within specified time ÷ number procedures for which prophylaxis is indicated × 100)
786	701	89.2

Table 6. Ventilator bundle compliance

Total number of patients on ventilators during that period	Total number of patients on ventilators with all of ventilator-associated pneumonia bundle implemented in a specific time period	Compliance rate (%) (number of patients with bundles completed ÷ total ventilator patients × 100)
62	54	87.1

Table 7. Appropriateness of urinary catheter usage

Total number of home care patients with indwelling catheters during the first month on home care service	Number of home care patients with approved indication for an indwelling catheter during the first month of home care service	Rate of appropriate usage (%) (number of patients meeting approved indication(s) ÷ total patients with catheters × 100)
76	68	89.5

Table 8. Immunization rates stratified by payor source

Payor source	Number of adults eligible for specific immunization (not immune by natural infection or vaccination)	Number immunized or "on time" with specified immunization	Immunization rate (%) (number of immunized ÷ number of eligible × 100)
Health maintenance organization A	2050	1855	90
Health maintenance organization B	4215	3899	93
Preferred provider organization A	3339	1736	52
Indemnity plan A	3677	980	27

1. A large ambulatory primary care clinic system serving adults and children chooses adult immunization rates as a performance improvement (PI) focus for the year. The quality manager decides to stratify by payor source because there is considerable variability in coverage for such prevention services (Table 8).
2. The neonatal intensive care unit (NICU) collaborative practice committee defines CLABSIs as a new surveillance objective. Rationale: high risk, high volume, and perceived substantial opportunity for improvement.

The following steps were developed by the collaborative practice group:

- NICU health unit coordinator to develop simple form with all infants by birthweight category, and print updated list daily.
- Nursing staff to note on form which infants have central lines at 7 AM daily.
- Health unit coordinator adds daily line days for month's total and forwards to the epidemiology office.
- Epidemiology staff is responsible to apply age-specific criteria for nosocomial BSI using CDC's NHSN definitions based on chart review and interviews with neonatologists.
- Epidemiology staff enters cases and line day counts into database.
- After assessing population size and the frequency of central line utilization, tentative plans are made to calculate and report device-specific incidence density rates and device utilization ratios every 6 months.
- Data reported from NHSN will be used for comparison.

For infection rate calculation, see Table 9. For device utilization ratios, see Table 10.

3. A freestanding ambulatory surgery center wants to stratify hepatitis B immunization rates. The decision is made to stratify by job class and by department (Table 11).
4. Surgeons at an orthopedic specialty hospital question whether traditional wound contamination classification is the best way to stratify their SSI data,

Table 9. Central line–associated bloodstream infection rates stratified by birthweight category

Birth weight (g)	Central line days	Number of central line–associated bloodstream infections	Infection rate per 1000 central line days (number of BSIs ÷ number of central line days × 1000)
≤750	357	7	19.6
751-1000	412	8	19.4
1001-1500	322	4	12.4
1501-2500	269	2	7.4
>2500	363	2	5.5

Table 10. Central line utilization ratios stratified by birthweight category

Birth weight (g)	Number of patient days	Number of central line days	Device utilization ratio (central line days ÷ patient days)
≤750	425	357	0.84
751-1000	532	412	0.77
1001-1500	699	322	0.46
1501-2500	518	269	0.52
>2500	627	363	0.58

Table 11. Immunization rates stratified by job class and department

	Total number of eligible employees	Total number of immunized or “on time” with hepatitis B vaccination series	Immunization rate (%) (number of immunized or on time ÷ number of eligible × 100)
Job class eg, RN	155	130	83.9
Department eg, Operating room	78	72	92.3

because most operations are class I (“clean”). The ICP reviews published literature and recommends implementing a procedure-specific, multivariate risk index as used in the CDC NNIS/NHSN system. After 6 months of data collection and stratification by this new method, the ICP presents data showing that the CDC SSI risk index is substantially more predictive of SSI than wound class alone.

Note: The following two examples are provided as examples only and do not represent validated stratification systems. They are included for illustrative purposes only. For some measurements there may be no known or validated stratification models.

5. A long-term care facility serves a variable population including ambulatory elderly, persons with Alzheimer’s disease, and persons with neuromuscular disorders. The quality manager uses a weighted scoring system for fall injury risk. Variable points are given for risk factors such as age, hemiplegia, and history of previous falls. The score is assigned daily. In addition to utilizing the index for prevention actions, it was decided to calculate fall rates by three risk categories (Table 12).

6. A subacute and rehabilitation facility serving populations such as patients with spinal cord injuries or head injuries and patients who have had strokes uses a scale for assessing pressure ulcer risk. Risk factors are counted and a risk score assigned daily to each patient. Scores based on five parameters are totaled and can range from 5 (lowest risk) to 20 (highest risk). The care assessment and planning council decided to use a simple two-level stratification system for rate calculations (Table 13).

RECOMMENDED PRACTICE VII

Reporting and using surveillance information

The demonstrable power of surveillance is in sharing findings with those who need to know and who can act on these findings to improve patient safety. Numerous examples in the scientific literature illustrate that heightened awareness by personnel of results of process and outcome monitoring significantly improves performance.¹³⁻¹⁹ A plan for the distribution of surveillance information should be incorporated into the development of each surveillance component. Surveillance results

Table 12. Fall rates stratified by risk category

Risk category	Number of patient days	Number of falls	Fall rate per 1000 patient days (number of falls ÷ number of patient days × 1000)
Green (low risk): 0-10 points	436	1	2.3
Yellow (medium risk): 11-20 points	528	4	7.6
Red (high risk): >20 points	265	3	11.3

Table 13. Pressure ulcer rates stratified by risk category

Risk score total	Total patient days	Total stage II, III, or IV ulcers	Rate per 1000 patient days (number of stage II, III, or IV ulcers ÷ number of patient days × 1000)
<10	335	1	3.0
≥10	416	4	9.6

should be reported to those health care providers who are most able to impact on and improve patient care. Reporting should be done in a systematic ongoing basis to ensure that information sharing is timely.

Practical applications

- Design each surveillance report to be user-friendly as well as to provide accurate, interpretable information.
- Ensure that clinicians and persons trained in epidemiology or data methodology collaborate in the interpretation of surveillance data.
- Use caution when submitting and/or interpreting surveillance data used for external or inter-facility comparisons. Comparisons are valid only if all contributors to the data have:
 - used the same surveillance intensity
 - used similar data collection methods
 - applied the same surveillance definitions
 - addressed differences in populations/case mix
 - stratified data as appropriate
- Report surveillance information in a manner to stimulate improvement of the process or outcome being measured. This can be incorporated into formal or informal organizational performance improvement efforts. Visual displays using charts, graphs, tables, or other graphics tools may be extremely useful in outlining surveillance data.

Examples

- The medical director of a freestanding home health agency with a large intravenous (IV) therapy service proclaimed to the quality improvement committee that they had a "huge" problem with line-related infections and suggested immediate implementation of mandatory education programs for all staff. The

leader of an existing care management team suggested contacting the agency's infection control consultant about how to approach the concern. The team reviewed the existing data and found that although there had been a recent increase in IV-associated infections, the rate per 1000 line days for the first 2 quarters of the current year was not significantly different than the previous years' experience. Further evaluation showed that the proportion of infections associated with peripherally inserted central catheter (PICC) lines was substantially higher in the current monitoring period. It was also found that increasing numbers of family members were becoming responsible for the care of the PICC lines. Improvement activities were developed, such as a patient and family teaching module, return demonstrations, a simplified access port system, and a preassembled catheter care tray. Subsequent monitoring revealed improvement in the overall rate of IV-associated infections and a significant reduction in the proportion of infections in clients with PICC lines. The team continued routine surveillance of IV infections but ultimately reduced the monitoring of patient/family care processes to random checks after the techniques had been successfully demonstrated for three successive visits.

- A chemical dependency unit had a policy to offer TB skin testing to all new clients. A retrospective record review showed only 30% were actually tested. Analysis of the initial data by the integrated care coordination team revealed the following:

- Poor documentation of which clients were actually eligible (eg, some were prior reactors, some had recent test results already available).
- No way to determine what percentage were offered but declined, rather than never offered because of oversight.

- No program to educate clients or staff about the importance of skin testing.

Actions taken: the care coordination team revised the intake form to include TB testing data and an area to document refusal or previous positive status. They worked with the local health department to utilize existing educational material and incorporated this into employee orientation and continuing education programs, competency checklists, and into unit orientation for new clients. Remonitoring after improvement efforts showed an acceptance rate of 90% in eligible clients.

3. An SICU with an active trauma service had participated in central-line bloodstream infection surveillance for 12 months. Following rate reporting after two 6-month cycles, a PI team was formed to examine opportunities for improvement because there was concern that the rate exceeded the CDC NHSN 90th percentile in both monitoring periods. The PI team identified two concerns:

- For staff convenience, central lines may remain in place longer than necessary.
- Policies for maximal barrier precautions, for hand hygiene, and for change frequency for pulmonary artery catheters were not routinely followed.

The team requested further assistance from the infection control specialist serving on the team to design a process surveillance method to evaluate compliance with insertion guidelines and to calculate device utilization ratios for comparison to data reported by the NNIS/NHSN system.

Findings: The unit device utilization ratio was very similar to the NHSN 50th percentile, indicating they were probably not over-utilizing central lines. The process monitor of compliance to policies showed that fewer than 60% were inserted under maximal barrier precautions and fewer than 30% of pulmonary artery catheters were changed according to policy. In addition, hand hygiene was appropriate in only 30% of patient contacts.

The PI team's improvement recommendations centered around re-education of physicians and nurses on the hospital's IV policies, on empowering nurses to stop the central line insertion process if all precautions were not followed, on changing supply processes to ensure all necessary components were available to support maximal barrier precautions for insertion, and on developing a reminder system for catheter change frequency (implementation and monitoring of central line bundles.)

4. An ICP has been reviewing SSI data with the Infection Control Committee. A quality team has been formed to address SSI prevention practices. Although the ICP is responsible for infection

monitoring, the operating room staff assist in process monitoring. To provide more meaningful feedback to clinicians, the ICP creates a letter to send to surgeons and anesthesiologists whenever an infection is detected. The letter will outline which processes, if any, were not implemented for each specific case. Monitored processes will include hair removal, antibiotic selection, dosing, timing of prophylaxis, glucose monitoring, and temperature. After 3 months of providing these letters to the involved physicians, infections decreased and a spot check of processes reveals higher compliance rates.

CONCLUSION

This document has outlined seven Recommended Practices for Surveillance. These practices are necessary for the success of a surveillance program in any health care setting. A well-implemented surveillance plan will serve a pivotal role in supporting high-quality care initiatives by providing systems for monitoring, measuring, and reporting important outcomes and processes. As stated by Alexander D. Langmuir, "Good surveillance does not necessarily ensure the making of the right decisions, but it reduces the chances of wrong ones."²⁰

The authors and the Association for Professionals in Infection Control and Epidemiology would like to thank the reviewers, Jill Corich, RN, CIC, and Mary Jane Ruppert, RN, HCS-D, COS-C, for their contributions to this recommendation.

References

1. Centers for Disease Control and Prevention. Updated guidelines for evaluating public health surveillance systems: recommendations from the guidelines working group. *MMWR* 2001;50:1-35.
2. Scheckler WE, Brimhall D, Buck AS, Farr BM, Friedman C, Garibaldi RA, et al. Requirements for infrastructure and essential activities of infection control and epidemiology in hospitals: a consensus panel report. *Am J Infect Control* 1998;26:47-60.
3. Friedman C, Barnette M, Buck AS, Ham R, Harris J-A, Hoffman P, et al. Requirements for infrastructure and essential activities of infection control and epidemiology in out-of-hospital settings: a consensus panel report. *Am J Infect Control* 1999;27:418-30.
4. Lee TB, Baker OG, Lee JT, Scheckler WE, Steele L, Laxton CE. APIC Surveillance Initiative Working Group. Recommended practices for surveillance. *Am J Infect Control* 1998;26:277-88.
5. Horan TC, Gaynes RP. Surveillance of nosocomial infections. In: Mayhall CG, editor. *Hospital epidemiology and infection control*. 3rd edition Philadelphia: Lippincott Williams & Wilkins; 2004. p. 1659-702.
6. National Healthcare Safety Network. NHSN manual: patient safety component protocols. Available from: <http://www.cdc.gov/ncidod/dhqp/nhsn.html>. Accessed August 16, 2007.
7. McGeer A, Campbell B, Emori TG, Hierholzer WJ, Jackson MM, Nicolle LE, et al. Definitions of infection for surveillance in long-term care facilities. *Am J Infect Control* 1991;19:1-7.
8. Goldrick BA. The Certification Board of Infection Control and Epidemiology white paper: the value of certification for infection control professionals. *Am J Infect Control* 2007;35:150-6.

9. Stone PW, Horan TC, Shih H-C, Mooney-Kane C, Larson E. Comparisons of health care-associated infections identification using two mechanisms for public reporting. *Am J Infect Control* 2007;35:145-9.
10. McKibben L, Fowler G, Horan T, Brennan PJ. Ensuring rational public reporting systems for health care-associated infections: systematic literature review and evaluation recommendations. *Am J Infect Control* 2006;34:142-9.
11. Braun BI, Kritchevsky SB, Kusek L, Wong ES, Solomon SL, Steele L, et al. Comparing bloodstream infection rates: the effect of indicator specifications in the evaluation of processes and indicators in infection control (EPIC) study. *Infect Control Hosp Epidemiol* 2006;27:14-22.
12. Sherman ER, Heydon KH, St. John KH, Teszner E, Rettig SL, Alexander SK, et al. Administrative data fail to accurately identify cases of healthcare-associated infection. *Infect Control Hosp Epidemiol* 2006;27:332-7.
13. Trick WE, Vernon MO, Welbel SF, DeMarais P, Hayden MK, Weinstein RA. Chicago Antimicrobial Resistance Project. Multicenter intervention program to increase adherence to hand hygiene recommendations and glove use and to reduce the incidence of antimicrobial resistance. *Infect Control Hosp Epidemiol* 2007;28:42-9.
14. Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med* 2006;355:2725-32.
15. Rosenthal VD, Maki DG, Salomao R, Moreno CA, Mehta Y, Higuera F, et al. International Nosocomial Infection Control Consortium. Device-associated nosocomial infections in 55 intensive care units of 8 developing countries. *Ann Intern Med* 2006;145:582-91.
16. Dellinger EP, Hausmann SM, Bratzler DW, Johnson RM, Daniel DM, Blunt KM, et al. Hospitals collaborate to decrease surgical site infections. *Am J Surg* 2005;190:9-15.
17. Gastmeier P, Geffers C, Brandt C, Zuschneid I, Sohr D, Schwab F, et al. Effectiveness of a nationwide nosocomial infection surveillance system for reducing nosocomial infections. *J Hosp Infect* 2006;64:16-22.
18. Lam BC, Lee J, Lau YL. Hand hygiene practices in a neonatal intensive care unit: a multimodal intervention and impact on nosocomial infection. *Pediatrics* 2004;114:565-71.
19. Babcock HM, Zack JE, Garrison T, Trovillion E, Jones M, Fraser VJ, et al. An educational intervention to reduce ventilator-associated pneumonia in an integrated health system: a comparison of effects. *Chest* 2004;125:2224-31.
20. Langmuir AD. The surveillance of communicable diseases of national importance. *N Engl J Med* 1963;268:182-91.
- care units—Pennsylvania, April 2001–March 2005. *MMWR* 2005;54:1013-6.
- Classen DC, Burke JP, Pestonik SL, Evans RS, Stevens LE. Surveillance for quality assessment: IV. Surveillance using a hospital information system. *Infect Control Hosp Epidemiol* 1991;12:239-44.
- Conti MT, Poulsen D. Performance indicators. In: Carrico R, editor. *APIC text of infection control and epidemiology*. Vol 1, 2nd ed. Washington, DC: Association for Professionals in Infection Control and Epidemiology; 2005;9-1—9-10.
- Cookson ST, Ihrig M, O'Mara EM, Hartstein AI, Jarvis WR. Use of an estimation method to derive an appropriate denominator to calculate central venous catheter-associated bloodstream infection rates. *Infect Control Hosp Epidemiology* 1998;19:28-31.
- Courtemanche J. Severity of illness indices. In: Carrico R, editor. *APIC text of infection control and epidemiology*. Vol 2, 2nd ed. Washington, DC: Association for Professionals in Infection Control and Epidemiology; 2005;32-1-6.
- Edwards JR, Horan TC. Developing and comparing infection rates. In: Carrico R, editor. *APIC text of infection control and epidemiology*. Vol 1, 2nd ed. Washington, DC: Association for Professionals in Infection Control and Epidemiology; 2005;7-1-8.
- Gastmeier P. Postdischarge surveillance for surgical site infection: the continuing challenge. *Infect Control Hosp Epidemiol* 2006;27:1287-90.
- Gaynes R, Richards C, Edwards J, Emori TG, Horan T, Alonso-Echanove J, et al; the National Nosocomial Infections Surveillance (NNIS) System Hospitals. Feeding back surveillance data to prevent hospital-acquired infections. *Emerging Infectious Diseases* 2001;7:295-8.
- Goss LK. Information technology. In: Carrico R, editor. *APIC text of infection control and epidemiology*. Vol 2, 2nd ed. Washington, DC: Association for Professionals in Infection Control and Epidemiology; 2005;33-1-9.
- Haas JP, Mendonca EA, Ross B, Friedman C, Larson E. Use of computerized surveillance to detect nosocomial pneumonia in neonatal intensive care unit patients. *Am J Infect Control* 2005;33:439-43.
- Haley RW. Nosocomial infections in surgical patients: developing valid measures of intrinsic patient risk. *Am J Med* 1991;91(Suppl 3B): 145S-51S.
- Horan TC, Emori TG. Definitions of key terms used in the NNIS system. *Am J Infect Control* 1997;25:112-6.
- Horan TC, Gaynes RP. Surveillance of nosocomial infections. In: Mayhall CG, editor. *Hospital epidemiology and infection control*. 3rd edition Philadelphia: Lippincott Williams & Wilkins; 2004. p. 1659-702.
- Klaucke DN, Buehler JW, Thacker SB, Parrish RG, Trowbridge FL, Berkelman RL. Guidelines for evaluating surveillance systems. *MMWR Morb Mortal Wkly Rep* 1988;37:1-18.
- Klevens RM, Tokars JI, Andrus M. Electronic reporting of infections associated with hemodialysis. *Nephrology News & Issues* 2005; June:37-43.
- Lee TB. Surveillance in acute care and nonacute care settings: current issues and concepts. *Am J Infect Control* 1997;25:121-4.
- Manian FA. Surveillance of surgical site infections in alternative settings: exploring the options. *Am J Infect Control* 1997;25:102-5.
- McKibben L, Horan T, Tokars JI, Fowler G, Cardo DM, Pearson ML, et al; the Healthcare Infection Control Practices Advisory Committee. Guidance on public reporting of healthcare-associated infections: recommendations of the Healthcare Infection Control Practices Advisory Committee. *Am J Inf Cont* 2005;33:217-26.
- Mylotte J. Analysis of infection control surveillance data in a long term care facility: use of threshold testing. *Infect Control Hosp Epidemiology* 1996;17:348-9.
- Pokorny L, Rovira A, Martin-Baranera M, Gimeno C, Alonso-Tarres C-Vilarasau J. Automatic detection of patients with nosocomial infection by a computer-based surveillance system: a validation study in a general hospital. *Infect Control Hosp Epidemiol* 2006;27:500-3.
- Sands K, Vineyard G, Platt R. Surgical site infections occurring after hospital discharge. *J Infect Dis* 1996;173:963-70.

RECOMMENDED READING

- Arias KM. Surveillance. In: Carrico R, editor. *APIC text of infection control and epidemiology*. 2nd edition. Washington, DC: Association for Professionals in Infection Control and Epidemiology; 2005. p. 3-1-18.
- APIC/SHEA/SIS Quality Indicator Study Group. An approach to the evaluation of quality indicators of the outcome of care in hospitalized patients, with a focus on nosocomial infection indicators. *Am J Infect Control* 1995;23:215-22.
- Baker OG. Process surveillance: an epidemiologic challenge for all health care organizations. *Am J Infect Control* 1997;25:96-101.
- Centers for Disease Control and Prevention. National Nosocomial Infections Surveillance (NNIS) report, data summary from January 1992–June 2004, issued October 2004. *Am J Infect Control* 2004;32:470-85 [and similar NHSN reports as published/posted in the future].
- Centers for Disease Control and Prevention. Nosocomial infection rates for interhospital comparison: limitations and possible solutions. *Infect Control Hosp Epidemiol* 1991;12:609-21.
- Centers for Disease Control and Prevention. Reduction in central line-associated bloodstream infections among patients in intensive

- Scheckler WE. Surveillance, foundation for the future: a historical overview and evolution of methodologies. *Am J Infect Control* 1997;25:106-11.
- Sherertz RJ, Garibaldi RA, Marosok RD, Mayhall CG, Scheckler WE, Berg R, et al. Consensus paper on the surveillance of surgical wound infections. *Am J Infect Control* 1992;20:263-70.
- Tokars JI, Richards C, Andrus M, Klevens M, Curtis A, Horan T, et al. The changing face of surveillance for health care-associated infections. *Clin Infect Dis* 2004;39:1347-52.
- Trick WE, Zagorski BM, Tokars JI, Vernon MO, Welbel SF, Wisniewski MF, et al. Computer algorithms to detect bloodstream infections. *Emerg Infect Dis* 2004;10:1612-20.
- Wisniewski MF, Kieszkowski P, Zagorski BM, Trick WE, Sommers M, Weinstein RA. Development of a clinical data warehouse for hospital infection control. *J Am Med Inform Assoc* 2003;10:454-62.

ON-LINE RESOURCES

- <http://www.cdc.gov/ncidod/dhqp>. CDC's Division of Healthcare Quality Promotion—infection prevention and control topics, guidelines, resources.
- http://www.cdc.gov/ncidod/dhqp/nhsn_members.html. Forms, protocols for CDC's National Healthcare Safety Network surveillance system.
- <http://www.apic.org>. Association for Professionals in Infection Control and Epidemiology—Resources, education.