Best Practices for Surveillance of Health Care-Associated Infections in Patient and Resident Populations

This document is current to June 2008, and is not updated. It was prepared at a time when PIDAC reported directly to the Minister of Health and Long-Term Care and Chief Medical Officer of Health. Note that effective April 1, 2011, the responsibility for and functions of the Provincial Infectious Diseases Advisory Committee ("PIDAC") were transferred to the Ontario Agency for Health Protection and Promotion ("Agency"), and that PIDAC now reports to that Agency. You may wish to consult www.pidac.ca or the Agency's website at www.oahpp.ca for more information.

Provincial Infectious Diseases Advisory Committee (PIDAC)

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This document was developed by the Provincial Infectious Diseases Advisory Committee (PIDAC). PIDAC is a multidisciplinary scientific advisory body who provide to the Chief Medical Officer of Health evidence-based advice regarding multiple aspects of infectious disease identification, prevention and control. PIDAC's work is guided by the best available evidence and updated as required. Best Practice documents and tools produced by PIDAC reflect consensus positions on what the committee deems prudent practice and are made available as a resource to the public health and healthcare providers.

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Best Practices for Surveillance of Health Care-associated Infections in Patient and Resident Populations

Executive Summary

This document provides hospitals and long-term care homes with recommended best practices for the establishment of a surveillance system to detect health care-associated infections (HAIs) within their facility.

What is Surveillance?

Surveillance is the systematic ongoing collection, collation and analysis of data with timely dissemination of information to those who require it in order to take action. The actions usually relate to improvements in prevention or control of the condition. Surveillance for health care-associated infections is normally performed by trained infection prevention and control professionals or hospital epidemiologists.

Why do Surveillance?

Health care-associated infections are an important and growing hospital and public health concern in Canada. Both the prevalence of antibiotic-resistant organisms and of a vulnerable, immunocompromised population are increasing in hospitals and long-term care homes. There is conclusive evidence to show that the establishment of a surveillance system for HAIs is associated with reductions in infection rates. Surveillance is also useful in monitoring the effectiveness of preventive and infection control programs.

How is Surveillance Performed?

There are several established components to an active, effective surveillance system:

1. Planning

   Because it is not feasible to monitor all types of infections at all times, choosing which infections will be surveyed is based upon an initial assessment that will establish the priorities for the surveillance system. An initial assessment will include:
   - the types of patients/residents that are served by the health care setting;
   - the key medical interventions and procedures that are provided in the health care setting;
   - the frequency of particular types of infections within a particular health care setting;
   - the impact of the infection (including per cent case fatality and excess costs associated with the infection); and
   - the preventability of the infection.

   Surveillance for some types of infections and syndromes, such as Febrile Respiratory Illness (FRI) and Gastrointestinal Illness (GI), are currently part of routine practice in all health care settings.

2. Data Collection

   Collection of infection data for surveillance purposes must be done using validated, published definitions for HAIs. If the definitions that are used to categorize an infection are not standardized, a health care setting's infection rates cannot be accurately compared to either their own historical infection rates or to external benchmarks.

In order to generate valid HAI rates, information must be collected on those who develop a HAI and those who do not develop infection. Electronic screening of patient records is an emerging tool for identification of potential HAIs. These computerized systems of case finding will reduce the time spent by infection control professionals in case finding.

Long-term care homes will have a more limited range of information available for case finding, relying on ongoing contact and feedback from those directly involved in resident care.

Post-discharge surveillance for surgical site infection is becoming an increasingly important component of a surveillance system in acute care, due to shorter hospital stays following surgeries and an increasing proportion of surgeries taking place in the outpatient setting. Innovative strategies that do not put undue burden on their program resources are encouraged in hospitals to detect surgical site infections.

3. Data Analysis

   It is recommended that incidence density rates be calculated (i.e., the measurement of new cases of infection (incidence) based on the time at risk in the patient/resident population, e.g., length of stay in a hospital or long-term care home) in hospitals and long-term care homes. Where medical devices are inserted and/or surgical procedures are performed, rates of device-associated or surgical site infection should also be calculated. It may be useful in hospitals to stratify rates of surgical site infections by standardized risk scores in order to compare the rates to other hospitals.

   An electronic spreadsheet/database and/or statistical analysis program should be used in hospitals and long-term care homes to store data and calculate HAI rates, to maximize infection prevention and control resources and reduce the potential for errors associated with manual calculations.

4. Interpretation of Data

   Surveillance data requires interpretation to identify areas where improvements to infection prevention and control practices can be implemented to lower the risk of HAI. Increases to a health care setting's HAI rate should trigger an investigation to look for changes in the hospital or long-term care home's activities that may explain the apparent change in the rate of infection. This investigation is particularly essential where major deviations from the baseline HAI rate may indicate the presence of an outbreak. Analysis and interpretation of infection data may be done with the facility's Infection Prevention and Control Committee or other advisory body to the Infection Control Team.

   HAI rates may be compared to both the facility's own previous HAI rates and benchmarks, or to external standards or benchmarks set by other health care settings. When comparing HAI rates to those of other health care settings, it is essential that the same case finding methods are used, the same case definitions are applied and the same methods for risk stratification are employed. It is a recommended practice that a set of peer facilities that serve a similar case mix, use the same case definitions and similar case finding methods be identified to serve as a comparison group.

5. Communication of Results

   Communication of surveillance data should take place on an ongoing, systematic basis and be targeted to those with the ability to change infection prevention and control practice. Communication may be targeted to:

   - a health care setting's Infection Prevention and Control Committee, which provides an aggregate picture of all infections of interest in the hospital;

- a particular patient/resident care area or specialty care area, focused on the risk of specific types of infections that are of importance to these groups;
- patient/resident care staff following the identification of an emerging risk of infection, to remind or notify of the required precautions in infection prevention and control.

6. Evaluation

   Periodic review of the surveillance system should be part of regular Infection Prevention and Control Committee meetings in hospitals and long-term care homes and should include an assessment of the outcomes to which the surveillance system contributes. Evaluation should include how information produced by a surveillance system is used to reduce the risk of health care-associated infection. Outcome evaluation should take place at least annually and a realignment of surveillance objectives undertaken when indicated.

The steps provided in this best practices guide will assist infection prevention and control professionals to develop and implement their surveillance programs in a manner that will permit comparisons with their peers and allow them to quickly detect early increases in health care-associated infections that may indicate the presence of an outbreak.

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1. Preamble

About This Document

This document is intended as a guide for Infection Control Professionals in acute and long-term care, to ensure that the critical elements and methods of surveillance for health care-associated infections (HAIs) are incorporated into their practice. It provides guidance for each of the building blocks of the surveillance system including planning, data collection, interpretation, analysis and communication, to inform infection prevention and control practices that will result in effective surveillance in hospitals and long-term care homes.

The best practices for surveillance described in this document should assist acute and long-term care settings in Ontario in establishing surveillance systems. Effective surveillance should lead to process improvements that will result in decreases in HAI rates, morbidity, mortality and health care costs. Although the primary audience for this document comprises those directly involved in surveillance, it also serves as a resource for anyone seeking to improve their understanding of best practices in nosocomial infection surveillance.

The best practices in this document recommend a standardized approach to the surveillance of health care-associated infections that will allow for the comparison of rates within facilities, across facilities as well as comparison to provincial and national benchmarks. This document forms one component of an effort to enhance patient safety and improve the quality of health care in Ontario.

Evidence for Recommendations

The principles and practices recommended in this document are a synthesis of the best available scientific evidence and expert opinion of professionals from the fields of infectious diseases, infection prevention and control, public health and epidemiology. It is our intention that as new information becomes available, recommendations in this document will be reviewed and updated.

How and When to Use This Document

The types of health care settings to which the guidance provided in this document applies are outlined in Box 1.

Box 1: Health Care Settings Impacted by this Document

This document applies to these health care settings:

- *Hospitals (tertiary care, community care, mental health, rehabilitation, etc.)*
- *Long-term/chronic care homes*
- *Complex continuing care settings*

This document does not apply to these health care settings:

- *Primary care*
- *Community health settings (clinics, physician offices, dental offices)*
- *Home health care*

Limitations to this Document

- This document deals with the surveillance of infections that result as an outcome of health care rather than on the processes contributing to changes in the risk of acquiring health care-associated infections. Monitoring of processes, such as hand hygiene and sterilization techniques, are addressed through the health care setting's practice audits, rather than through the outcome surveillance systems as described in this best practices guide. For more information regarding process surveillance, see the Ministry of Health and Long-Term Care's "*Best Practices for Infection Prevention and Control Programs in Ontario in All Health Care Settings*".[1]

- This document does not proscribe how much surveillance should be done in individual facilities, nor does it dictate what should be surveyed. It is acknowledged that different facilities may implement these best practices in different ways, depending on the resources available to them. For more information regarding recommendations for surveillance targets, see the Ministry of Health and Long-Term Care's "*Best Practices for Infection Prevention and Control Programs in Ontario in All Health Care Settings*".[1]

- This document provides guidance for routine surveillance programs and is not intended as a guide for infection surveillance during outbreaks. However, it is recognized that baseline HAI rates established by a well-functioning, ongoing surveillance system are essential to assist in outbreak identification by indicating increases above the norm. Once an outbreak is suspected, health care settings must notify their local Medical Officer of Health (institutional outbreaks are reportable under the *Health Protection and Promotion Act*[2]) and outbreak management should be undertaken in collaboration with the local public health authorities.

- Specific surveillance recommendations for syndromic surveillance, antibiotic-resistant microorganisms and *Clostridium difficile* are not included in this document. Refer to the following Ontario documents for specific surveillance methodologies:

    - Syndromic surveillance
        - *Infection Control in the Physician's Office*. College of Physicians and Surgeons of Ontario.[3]
          Available at: http://www.cpso.on.ca/Publications/infectioncontrolv2.pdf
    - Acute respiratory infection surveillance
        - *Preventing Febrile Respiratory Illnesses: protecting patients and staff. Best Practices in Surveillance and Infection Prevention and Control for Febrile Respiratory Illness (FRI), excluding Tuberculosis, for All Ontario Health Care Settings*.[4] Revised March, 2008.
          Available at:
          http://www.health.gov.on.ca/english/providers/program/infectious/diseases/best_prac/bp_fri_080406.pdf
        - *A Guide to the Control of Respiratory Infection Outbreaks in Long-Term Care Homes*.[5] October 2004.
          Available at:
          http://www.health.gov.on.ca/english/providers/pub/pubhealth/ltc_respoutbreak/ltc_respoutbreak.pdf
    - Antibiotic-resistant organism surveillance
        - *Best Practices for Infection Prevention and Control of Resistant Staphylococcus aureus and Enterococci in All Health Care Settings*.[6] March 2007.
          Available at:
          http://www.health.gov.on.ca/english/providers/program/infectious/diseases/best_prac/bp_staff.pdf.
    - *Clostridium difficile* surveillance

- *Best Practices Document for the Management of Clostridium difficile in All Health Care Settings*.[7] Revised November 2007.
  Available at:
  http://www.health.gov.on.ca/english/providers/program/infectious/diseases/best_prac/bp_cdiff.pdf.

- Staff surveillance
  - *Communicable Disease Surveillance Protocols*. Ontario Hospitals Association and Ontario Medical Association. These Protocols provide direction for surveillance and management of specific infections among hospital staff.
    Available at:
    http://www.oha.com/client/oha/oha_lp4w_lnd_webstation.nsf/page/Communicable+Diseases+Surveillance+Protocols.

Illustrations and Symbols

Throughout the document, illustrations are used to demonstrate the concepts described in the text. These illustrations are meant as examples of how the recommended best practices outlined in this document could be applied in an acute and a long-term care setting. The illustrations used are:

- City General Hospital – a fictitious acute care hospital
- Forest Manor – a fictitious long-term care home

The following symbols are used throughout the document:

"**Recommended Best Practices**" are annotated with this symbol. These practices are recommended by PIDAC based on the best available evidence as a standardized approach to surveillance. All recommended best practices are summarized at the end of the document.

"**Pearls of Wisdom**" are annotated with this symbol and provide lessons from those with longstanding experience in the field of surveillance. Pearls of wisdom draw attention to commonly overlooked areas and, in some cases, common pitfalls in undertaking surveillance.

"**Surveillance Tools**" are annotated with this symbol and refer to a set of practical tools that may be used to implement the recommended best practices.

Assumptions and General Principles

The best practices in this document are based on the assumption that basic infection prevention and control systems are in place in health care settings in Ontario. Without a basic system of infection prevention and control in place, appropriate resources for surveillance system planning, data collection and analysis as well as improvements to infection prevention and control practices based on the information provided by the surveillance system will be difficult to identify.

Collaboration with organizations that have infection prevention and control expertise, such as academic health science centres, regional infection control networks, public health units that have professional staff certified in infection prevention and control and local infection prevention and control associations (e.g., Community and Hospital Infection Control Association – Canada chapters) may be necessary to develop evidence-based programs.

In addition to the general assumption (above) regarding basic infection prevention and control, these best practices are based on the following additional assumptions and principles:

1. Adequate resources are devoted to infection prevention and control in all health care settings. See the Ministry of Health and Long-Term Care's "*Best Practices for Infection Prevention and Control Programs in Ontario in All Health Care Settings*".[1]

2. Programs are in place in all health care settings that promote good hand hygiene practices and ensure adherence to standards for hand hygiene. See the Ministry of Health and Long-Term Care's *"Best Practices for Hand Hygiene in All Health Care Settings*".[8]
   Available at:
   http://www.health.gov.on.ca/English/providers/program/infectious/diseases/ic_hh.html.
   See also Ontario's hand hygiene improvement program, "*Just Clean Your Hands*", available at: http://www.justcleanyourhands.ca.

3. Adequate resources are devoted to Environmental Services/Housekeeping in all health care settings, including written procedures for cleaning and disinfection of client/patient/resident rooms and equipment; education of new cleaning staff and continuing education of all cleaning staff; and ongoing review of procedures.

4. A climate that is conducive to following and maintaining Routine Practices in all health care settings is promoted. This includes the set up and organization of the health care setting in order to provide a system that supports and promotes effective hand hygiene.

5. Best practices to prevent and control the spread of infectious diseases are routinely implemented in health care settings, including Health Canada's "*Routine Practices and Additional Precautions for Preventing the Transmission of Infection in Health Care" (Can Commun Dis Rep. 1999; 25 Suppl 4:1-142)* [under revision]).[9] Available at: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/99vol25/25s4/index.html.

6. Programs are in place in all health care settings that ensure effective disinfection and sterilization of used medical equipment according to the Ministry of Health and Long-Term Care's "*Best Practices for Cleaning, Disinfection and Sterilization in All Heath Care Settings*".[10] Available at:
   http://www.health.gov.on.ca/english/providers/program/infectious/diseases/ic_cds.html.

7. Regular education (including orientation and continuing education) and support to help staff consistently implement appropriate infection prevention and control practices is provided in all health care settings.

   Effective education programs emphasize:

   - the risks associated with infectious diseases;
   - hand hygiene, including the use of alcohol-based hand rubs and hand washing;
   - principles and components of Routine Practices as well as additional transmission-based precautions;
   - assessment of the risk of infection transmission and the appropriate use of personal protective equipment (PPE), including safe application, removal and disposal;

- appropriate cleaning and/or disinfection of health care equipment, supplies and surfaces or items in the health care environment;
- individual staff responsibility for keeping clients/patients/residents, themselves and co-workers safe; and
- collaboration between professionals involved in occupational health and infection prevention and control.

NOTE: Education programs should be flexible enough to meet the diverse needs of the range of health care providers and other staff who work in the health care setting. The local public health unit and regional infection control networks may be a resource and can provide assistance in developing and providing education programs for community settings.

8. Collaboration between professionals involved in occupational health and infection prevention and control is promoted in all health care settings to implement and maintain appropriate infection prevention and control standards that protect workers.

9. There are effective working relationships between the health care setting and the local public health unit. Clear lines of communication are maintained and public health is contacted for information and advice as required and the obligations (under the *Health Protection and Promotion Act,* R.S.O. 1990, c.H.7)[2] to report reportable and communicable diseases is fulfilled. Public health provides regular aggregate reports of outbreaks of any infectious diseases in facilities and/or in the community to all health care settings.

10. Access to ongoing infection prevention and control advice and guidance to support staff and resolve differences is available to the health care setting.

11. There are established procedures for receiving and responding appropriately to all international, national, regional and local health advisories in all health care settings. Health advisories are communicated promptly to all staff responsible for case finding/surveillance and regular updates are provided. Current advisories are available from local Public Health units, the Ministry of Health and Long-Term Care (MOHLTC), Health Canada and Public Health Agency of Canada websites and local regional infection prevention and control networks.

12. Where applicable, there is a process for evaluating personal protective equipment (PPE) in the health care setting, to ensure it meets quality standards.

13. There is regular assessment of the effectiveness of the infection prevention and control education program and its impact on practices in the health care setting. The information is used to further refine the program.

14. The *Communicable Disease Surveillance Protocols* and other legislated requirements must be adhered to by all hospitals (*Public Hospitals Act* Reg. 965). Available at: http://www.oha.com/client/oha/oha_lp4w_lnd_webstation.nsf/page/Communicable+Diseases+Surveillance+Protocols.

15. Health care settings report back to staff on the impact of their surveillance efforts (e.g., benefits of case finding/surveillance and preventive practices in the workplace in terms of client/patient/resident safety, client/patient/resident and staff illness and outbreaks).

16. Health care settings have an established relationship between Infection Prevention and Control and the Microbiology Laboratory, to support the Infection Prevention and Control program. This includes appropriate utilization of laboratory facilities, the ability to process screening specimens in a timely fashion and laboratory support during outbreaks.

Abbreviations

ARO	Antibiotic-resistant Organism
ASA	American Society of Anesthesiologists
BSI	Bloodstream Infection
CABG	Coronary Artery Bypass Graft
CCC	Complex Continuing Care
CDAD	*Clostridium difficile*-associated Disease
CNISP	Canadian Nosocomial Infection Surveillance Program
CHICA	Community and Hospital Infection Control Association - Canada
CVC	Central Venous Catheter
ESBL	Extended-spectrum Beta Lactamase
FRI	Febrile Respiratory Illness
GI	Gastrointestinal Illness
HAI	Health Care-associated Infection
ICP	Infection Prevention and Control Professional
ICU	Intensive Care Unit
ILI	Influenza-like Illness
LTC	Long-term Care
MRSA	Methicillin-resistant *Staphylococcus aureus*
NNIS/NHSN	National Nosocomial Infection Surveillance/ National Healthcare Safety Network
PHAC	Public Health Agency of Canada
RICN	Regional Infection Control Networks
SENIC	Study on the Effectiveness of Nosocomial Infection Control
SSI	Surgical Site Infection
UTI	Urinary Tract Infection
VAP	Ventilator-associated Pneumonia
VRE	Vancomycin-resistant Enterococcus

Glossary of Terms

Active Surveillance for Health Care-associated Infections: The direct and vigorous search for information on the occurrence of health care-associated infections in order to detect a change or trend in incidence rate. This is in contrast to passive surveillance, where data are not actively solicited. See also, *Passive Surveillance for Health Care-associated Infections*, below.

Antibiotic Resistant Organism (ARO): A microorganism that has developed resistance to the action of several antimicrobial agents and that is of special clinical or epidemiological significance (e.g. MRSA, VRE).

Benchmark: A validated figure that may be used for comparison provided data are collected in the same way as that of the benchmark data. Benchmarks are used to compare HAI rates to a standardized database that uses the same definitions for infection and is appropriately adjusted

for patient risk factors so that meaningful comparisons can be made. Comparing HAI rates to a validated benchmark will indicate whether the rates are below or above the recognized average.

Canadian Nosocomial Infection Surveillance Program (CNISP): The Public Health Agency of Canada's (PHAC) Centre for Infectious Disease Prevention and Control (CIDPC) and the Association of Medical Microbiology and Infectious Disease (AMMI) Canada partner in this national health care surveillance project. CNISP has two main areas of activity: (1) monitoring of important nosocomial pathogens (e.g. MRSA, *C. difficile*, VRE, ESBL); and (2) surveillance of specific types of nosocomial infections including those associated with central venous catheters, ventricular shunts and other surgeries. Thirty-five hospitals across Canada participate in CNISP surveillance projects.

CHICA-Canada: The Community and Hospital Infection Control Association of Canada, a professional organization of persons engaged in infection prevention and control activities in health care settings. CHICA-Canada members include infection prevention and control professionals from a number of related specialties including nurses, epidemiologists, physicians, microbiology technologists, public health and industry. The CHICA-Canada website is located at: http://www.chica.org.

Complex Continuing Care (CCC): Complex continuing care provides continuing, medically complex and specialized services to both young and old, sometimes over extended periods of time. Such care also includes support to families who have palliative or respite care needs. It plays an integral role in the treatment offered in Ontario hospitals.

Data Mining: The process of sorting through large amounts of data and picking out relevant information. An example of data mining for surveillance is the extraction of patients with symptoms or diagnostic test results that indicate potential cases with health care-associated infection from large patient information systems.

Denominator: Represents the population at risk.

Endemic: The constant presence of a disease or infectious agent within a certain area.

Endemic Rate: A baseline or expected rate of infection.[11] Knowledge of the endemic rate of infection in a hospital or long-term care home can assist in identifying major deviations from this baseline that may indicate the presence of an outbreak. More importantly, through surveillance, hospitals and long-term care homes can evaluate whether reductions to endemic rates resulted following modifications to infection prevention and control practices.

Health Care-associated Infection (HAI): A term relating to an infection that is acquired during the delivery of health care. See also, *Nosocomial Infection*, below.

Health Care Facility: A set of physical infrastructure elements supporting the delivery of health-related services. A health care facility does not include a client/patient/resident's home or physician offices where health care may be provided.

Health Care Setting: Any location where health care is provided, including settings where emergency care is provided, hospitals, complex continuing care, rehabilitation hospitals, long-term care homes, mental health facilities, outpatient clinics, community health centres and clinics, physician offices, dental offices, offices of allied health professionals and home health care.

Hospital-wide Surveillance: All care areas are continuously and prospectively surveyed for all conditions or events of interest.

Incidence Density: The measurement of new cases of infection (incidence) based on the time at risk in the patient population (e.g. length of stay in hospital, length of exposure to a device). An incidence density rate expresses the risk of infection in '*person time*', or the amount of time that a person spends at risk.[11]

Incidence Rate: A measurement of new cases of disease within a population over a given period of time.[11] The numerator is the number of new cases detected and the denominator is the initial population at risk for developing the particular infection or event during a given time frame.

Infection Prevention and Control: Evidence-based practices and procedures that, when applied consistently in health care settings, can prevent or reduce the risk of transmission of microorganisms to health care providers, other clients/patients/residents and visitors.

Infection Prevention and Control Professional(s): Trained individual(s) responsible for a health care setting's infection prevention and control activities. In Ontario an ICP must receive a minimum of 80 hours of instruction in a CHICA-Canada endorsed infection control program within six months of entering the role and must acquire and maintain Certification in Infection Control (CIC®) when eligible. The ICP should maintain a current knowledge base of infection prevention and control information.

Infection Risk: The probability that a patient/resident will acquire an infection based on the characteristics of the individual, the inherent risks associated with a procedure, or other factors that might put the individual at risk for a health care-associated infection.

Inter-rater Reliability: A measurement of the agreement between two individuals, for example in coding or diagnosis. In surveillance of nosocomial infections, the inter-rater reliability for identification of nosocomial infections might be assessed by having two ICPs apply a case definition for infection to a case series of potential infections. The degree of agreement would then be the proportion of cases that were defined in the same way by each ICP.

Long-Term Care (LTC): A broad range of personal care, support and health services provided to people who have limitations that prevent them from full participation in the activities of daily living. The people who use long-term care services are usually the elderly, people with disabilities and people who have a chronic or prolonged illness.

National Healthcare Safety Network (NHSN): See *National Nosocomial Infection Surveillance (NNIS/NHSP)*, below.

National Nosocomial Infection Surveillance (NNIS): The original NNIS System, a project of the Centers for Disease Control and Prevention, provides aggregate data compiled since 1992 from 300 USA acute care settings. NNIS HAI rates may be used for benchmarking acute care HAI rates provided that the same standardized definitions for infection are used. NNIS results are stratified by patient risk index. NNIS is currently known as NHSN (National Healthcare Safety Network). More information is available at:
http://www.cdc.gov/ncidod/dhqp/nnis_pubs.html.

NNIS/NHSN SSI Risk Index: A score used to predict a patient's risk of acquiring a surgical site infection. The risk index score, ranging from 0 to 3, indicates the number of infection risk factors present. One point is scored for each of the following: a) a patient with an American Society of Anesthesiologists' physical status classification score of 3, 4, or 5; b) an operation classified as contaminated or dirty/infected; and c) an operation lasting greater than T hours, where T is the recommended average operation length of time assigned to the operation being performed.

Nosocomial Infection: Infection acquired during the delivery of health care within a particular health care facility. See also, *Health Care-associated Infection*, above.

Numerator: Represents each event/infection that occurs during the surveillance period.

Outbreak: For the purposes of this document, an outbreak is an increase in the number of cases above the number normally occurring in a particular health care setting over a defined period of time.

Outcome surveillance: Surveillance used to measure client/patient/resident outcomes (changes in the client/patient/resident's health status that can be attributed to preceding care and service). An example of outcome surveillance related to infection prevention and control is surveillance of HAI rates. Outcome surveillance reflects the efficacy of the infection prevention and control program in protecting clients/patients/residents, health care providers and visitors from health care-associated infections while decreasing costs from infections.

Passive Surveillance for Health Care-associated Infections: Identification of health care-associated infections through established event reporting procedures by staff whose primary responsibility is patient/resident care. This is in contrast to active surveillance, where data are actively solicited. See also, *Active Surveillance for Health Care-associated Infection*, above.

Patient/resident: Any person receiving care within a hospital or long-term care home.

Periodic Surveillance for Health Care-associated Infections: Surveillance undertaken over a specified time interval (e.g. one month each quarter) in a health care setting. Some infection prevention and control programs will conduct surveillance on one or more units for a period of time and then shift to another unit or group of units. This rotation provides a less costly method to collect information on all high risk patient care areas.

Prevalence Survey for Health Care-associated Infections: Surveillance for all existing and new nosocomial infections in a health care setting either on a single day (*point prevalence*) or over a specified number of days (*period prevalence*). Data from each patient/resident is collected only once. A prevalence survey can provide a rapid, inexpensive way to estimate the global view and magnitude of health care-associated infections in a health care setting at a single point in time. It should also be noted that while a prevalence survey provides a picture of nosocomial infections at a single point in time, this risk estimate can be affected by the context for infection at that time. For instance, a prevalence survey for nosocomial respiratory infections during the winter months may indicate a higher risk of infection due to the seasonal occurrence of these events.

Process Surveillance: Surveillance used to assess or measure client/patient/resident processes (things done to or for a patient/resident during their encounter with the health care system). An example of process surveillance related to infection prevention and control is planned audits to verify that procedures and/or standards of practice are being followed.

Provincial Infectious Diseases Advisory Committee (PIDAC): A multidisciplinary scientific advisory body who provide to the Chief Medical Officer of Health evidence-based advice regarding multiple aspects of infectious disease identification, prevention and control. More information is available at: http://www.pidac.ca.

Public Health Agency of Canada (PHAC): A national agency which promotes improvement in the health status of Canadians through public health action and the development of national guidelines. The PHAC website is located at: http://www.phac-aspc.gc.ca/new_e.html.

Regional Infection Control Networks (RICN): The RICN of Ontario coordinate and integrate resources related to the prevention, surveillance and control of infectious diseases across all health care sectors and for all health care providers, promoting a common approach to infection prevention and control and utilization of best-practices within the region. There are 14 regional networks in Ontario. More information is available at: http://www.ricn.on.ca.

Risk Stratification: Stratification is a process to control for differences in the underlying risk factors for infection. Risk stratification involves calculating separate rates for patients/residents with similar susceptibilities to health care-associated infections, or those in the same category of risk (e.g. surgeon-specific infection rates).

Sensitivity: Proportion of persons with true positive results among persons known to have a disease.

Sentinel Event: A colonization/infection in which the occurrence of perhaps even a single case may signal the need to re-examine preventive practices.

Specificity: Proportion of persons with true negative results among persons without the disease.

Standard Deviation in a Surveillance Rate: The average distance that a surveillance rate in a particular period can be expected to deviate from the overall mean rate of infection observed in a health care setting. For example, if the mean rate of surgical site infection following hip replacement surgery over a ten-year period in a hospital is 3.5 per 100 procedures with a standard deviation of 1.0, then the rate of infection will be in the range of 2.5 to 4.5 per 100 surgical site infections. A rate of infection that is more than two standard deviation units from the mean rate (e.g. >5.5 per 100 in the above example) is much more than the expected variation in the rate of infection and should prompt immediate investigation. Two standard deviations represents 95.5% of all results.

Surveillance: The systematic ongoing collection, collation and analysis of data with timely dissemination of information to those who require it in order to take action.[12]

Syndromic Surveillance: Syndromic surveillance is the detection of individual and population health indicators of illness (i.e., signs and symptoms of infectious disease) that are discernible before confirmed laboratory diagnoses are made.

Targeted Surveillance: Surveillance that is focused on certain health care setting areas (e.g. intensive care unit), patient populations (e.g. surgical patients) and/or infection types (e.g. bloodstream infections, indwelling catheter-associated urinary tract infections) that have been identified as a priority within the health care setting.

2. Best Practices for Surveillance of Health Care-associated Infections in All Health Care Settings

2.1 Purpose of Surveillance

With the emergence antibiotic-resistant organisms (AROs) in health care settings, increasingly immunocompromised patients in acute care and increasing numbers of individuals requiring long-term care and complex continuing care, health care-associated infections (HAIs) represent an important and growing challenge to the entire health care system. A large proportion of HAIs are preventable and the scientific literature has established that incorporating surveillance systems into infection prevention and control activities are a means to reduce the frequency of these events.

2.2 What is a surveillance system?

Surveillance is defined as "*the ongoing, systematic collection, analysis, interpretation and evaluation of health data closely integrated with the timely dissemination of this data to those who need it*".[12] There are two key aspects of surveillance systems:

a) surveillance is an *organized* and *ongoing* component of a program to improve a specific area of population health; and
b) surveillance systems *go beyond the collection of information*; they involve mechanisms through which the knowledge gained through surveillance is delivered to those who can use it to direct resources where needed to improve health.

Rationale for Surveillance Systems in Acute and Long-term Care Settings

Health care-associated infections are a major and continuing challenge in hospitals and long-term care homes. It is estimated that 220,000 infections are acquired in hospitals each year in Canada, resulting in 8,000 deaths.[13] HAIs are also very costly, with a US estimate of $ 4 billion and a UK estimate of 900 million pounds associated with the prolonged stay and treatment costs for infections acquired in hospitals per year.[14, 15] The rapid increase of AROs has added to the impact of HAIs. Canadian surveillance data shows a greater than five-fold increase in the rates of methicillin-resistant *Staphylococcus aureus* (MRSA) in hospitals since 1995.[16] The recent increase of *Clostridium difficile*-associated disease (CDAD) is also associated with substantial excess morbidity, mortality and health care costs. Miller et al. noted the frequent occurrence of medical complications and mortality associated with nosocomial CDAD.[17] The hospital care and drug costs associated with nosocomial CDAD readmissions alone were projected at $128,500 per hospital per year in Canada.

HAIs are also common in long-term care homes, frequently resulting in death. Estimates of the rates of health care-associated infection in long-term care homes range from 1.8 to 13.5 per 1000 patient care days,[18] which is comparable to that in the hospital setting.[19] As the numbers of individuals requiring long-term care is expected to rise dramatically in the coming years, increased resources for infection prevention and control in this care setting will be an important factor to overall health.[1]

It is estimated that between 30% and 50% of health care-associated infections are preventable.[13, 20-23] Therefore, an infection prevention and control program that is effective in preventing HAIs can substantially reduce health care costs and, more importantly, the morbidity and mortality associated with HAIs.

Evidence to Support Best Practices in Surveillance

A surveillance system in hospitals and long-term care homes forms an integral part of an infection prevention and control program aimed at reducing health care-associated infections. In order to demonstrate the impact of surveillance on nosocomial infections in health care settings, a critical appraisal of the evidence documenting changes to the risk of infection following the establishment of a surveillance system was undertaken:

a) A systematic review of the scientific literature identified 11 studies that examined changes in the rates of nosocomial infections following the introduction of nosocomial surveillance.[23-33]
b) The studies compared the risk of nosocomial infection at the beginning of a surveillance program (before any impacts associated with the program could be expected) to the risk of infection after the surveillance program was established and operational.
c) There was a clear connection between implementation of a surveillance program and subsequent decline in the rates of nosocomial infection. Reductions in the rates of nosocomial infections generally ranged from 7% to 60% following the implementation of surveillance programs.
d) Several of the studies indicated that the reductions in rates of nosocomial infections were the result of changes to infection prevention and control practices informed by the feedback provided by the surveillance system.[25, 27, 32, 33]

Refer to Appendix A for the methods used to conduct this review and the evaluative criteria applied to the studies.

The mechanisms through which surveillance reduces the risk of nosocomial infection in hospitals are undoubtedly multi-factorial. The *Hawthorne Effect* (i.e. practices improve when increased attention is brought to them) may play a major role. Also, the presence of an Infection Control Professional (ICP) in a particular care area may increase dialogue and awareness of standards for infection prevention and control.

Haley's 1980's landmark "Study *on the Efficacy of Nosocomial Infection Control (SENIC Project)*"[34] demonstrated that a comprehensive, organized surveillance system with a physician trained in infection prevention and control and one ICP per 250 patient beds was associated with reduced rates of nosocomial infection.[23] Haley's study also found that feedback of infection rates to surgeons was an essential surveillance component to reduce surgical site infection. Both Canadian and US expert panels have used SENIC as a basis for their recommendations for essential infrastructure and personnel resources for infection prevention and control in hospitals and long-term care homes since the publication of this study.

In recent years, an inventory of resources for surveillance and infection prevention and control activities, '*Resources for Infection Control in Canadian Hospitals (RICH)'*, conducted by Zoutman et al found that a substantial proportion of hospitals still lack the essential resources to carry out surveillance.[35] RICH data also demonstrated that Canadian hospitals with sophisticated surveillance systems experienced lower rates of infections caused by antibiotic-resistant organisms.[36] The RICH study has recently been expanded to long-term care with similar findings relating to inadequately developed surveillance systems.[37]

Current recommendations for infection prevention and control resources take into account the complexity of today's health care settings and varied case mixes.[21, 38] More information may be found in the Ministry of Health and Long-Term Care's '*Best Practices for Infection Prevention and Control Programs in Ontario in All Health Care Settings'.*[1]

Pearl of wisdom: An effective surveillance system can reduce the frequency of nosocomial infection

2.3 Elements of Surveillance

Surveillance systems for infections in acute and long-term care homes serve several related purposes towards the end goal of reducing the risk of acquiring health care-associated infection:

Detect and Monitor

A well-functioning surveillance system provides the means to establish the endemic, or baseline, rate of nosocomial infection in a health care setting. The vast majority (90-95%) of nosocomial infections do not occur within the context of an identified outbreak,[39] but reflect areas where improvements may be made that will result in a sustained lowering of the endemic rate. While surveillance can assist in the detection of outbreaks in hospitals and long-term care homes by identifying significant deviations from the baseline rate, a more central purpose of ongoing surveillance is to monitor changes in the endemic rate of infection that indicate areas to focus improvements.

Identify Risk Factors for Health Care-associated Infection

The data collected as part of a surveillance system in a health care setting can be used to identify patients or residents at high risk for nosocomial infections or practices associated with a high risk of infection. For example, the US National Nosocomial Infection Surveillance/National Healthcare Safety Network (NNIS/NHSN) data have been used to compare the risk of surgical site infection among patients undergoing open vs. laparoscopic cholecystectomy.[40]

Risk factors for nosocomial infection, such as urinary incontinency, presence of an indwelling catheter, skin ulcers and chronic conditions such as heart disease, have all been identified in the long-term care context through the used of surveillance data.[41]

Evaluate Preventive Interventions

Following the implementation of preventive practices, data from the surveillance system can be used to investigate whether the measures were effective in achieving their intended outcome of improved infection control. Data collected through surveillance can also identify ineffective infection prevention and control measures, an example of which is provided in Box 2.

Box 2: Example of the Use of Surveillance to Identify Ineffective Practices: Discontinuation of pre-operative shaving practices

In two Calgary hospitals, pre-operative shaving with razor of the intended surgical wound site was found to be associated with a higher risk of surgical site infection. Although pre-operative shaving was once thought to reduce the risk of surgical site infection, information provided by the surveillance system demonstrated a sustained decline in the risk of surgical site infection in both hospitals following the discontinuation of this practice.

Cruse PJ, Surg Clin North Am 1980

Provide Information to Inform, Educate and Reinforce Practice

The continued presence of a surveillance system can increase awareness of infection prevention and control practices through discussions initiated by ICPs as they gather information from wards. Barwolff et al. noted that the decrease in rates of surgical site infection following Caesarean delivery in several German hospitals was attributed to the increased awareness of the risks of surgical site infection and of standards in infection prevention and control generated by the presence of the surveillance program in the obstetrics wards.[31]

Regular contact with ICPs can also identify areas where changes to infection prevention and control practices could lower the rates of infection in high risk areas. For example, regular contact of ward nurses with the ICP in a long-term care home over the course of an influenza season can serve to remind staff of appropriate infection prevention and control practices (e.g. cohorting, droplet precautions) for residents developing '*influenza-like*' illnesses (ILIs).

Evidence of the effectiveness of preventive interventions in one's own health care setting also serves to reinforce practice. The use of surveillance data from one's own facility, demonstrating the effect of infection prevention and control practices on nosocomial infections, can be successful in building awareness of the benefits of preventive practices.

2.4 Best Practices

Different health care settings serve different patient populations, offer different diagnostic procedures and treatments and have a varying proportion of care that is offered in inpatient vs. outpatient settings. As a result, the priorities and information needs of a surveillance system will vary across health care settings. Additionally, the resources available for the establishment and operation of a surveillance system are also expected to vary by facility.

The general steps required in setting up a surveillance program can be followed by any hospital or long-term care home in planning and implementing their surveillance system:

a) Assess the population to be surveyed;
b) Select the outcome(s) for surveillance;
c) Establish case definitions for infection;
d) Collect the surveillance data;
e) Calculate and analyse surveillance rates;
f) Apply risk stratification methodology where applicable;
g) Interpret HAI rates;
h) Communicate and use surveillance information to improve practice; and
i) Evaluate the surveillance system.

Figure 1 situates these recommended steps within the planning, data collection, analysis, interpretation, communication and evaluation phases of surveillance.

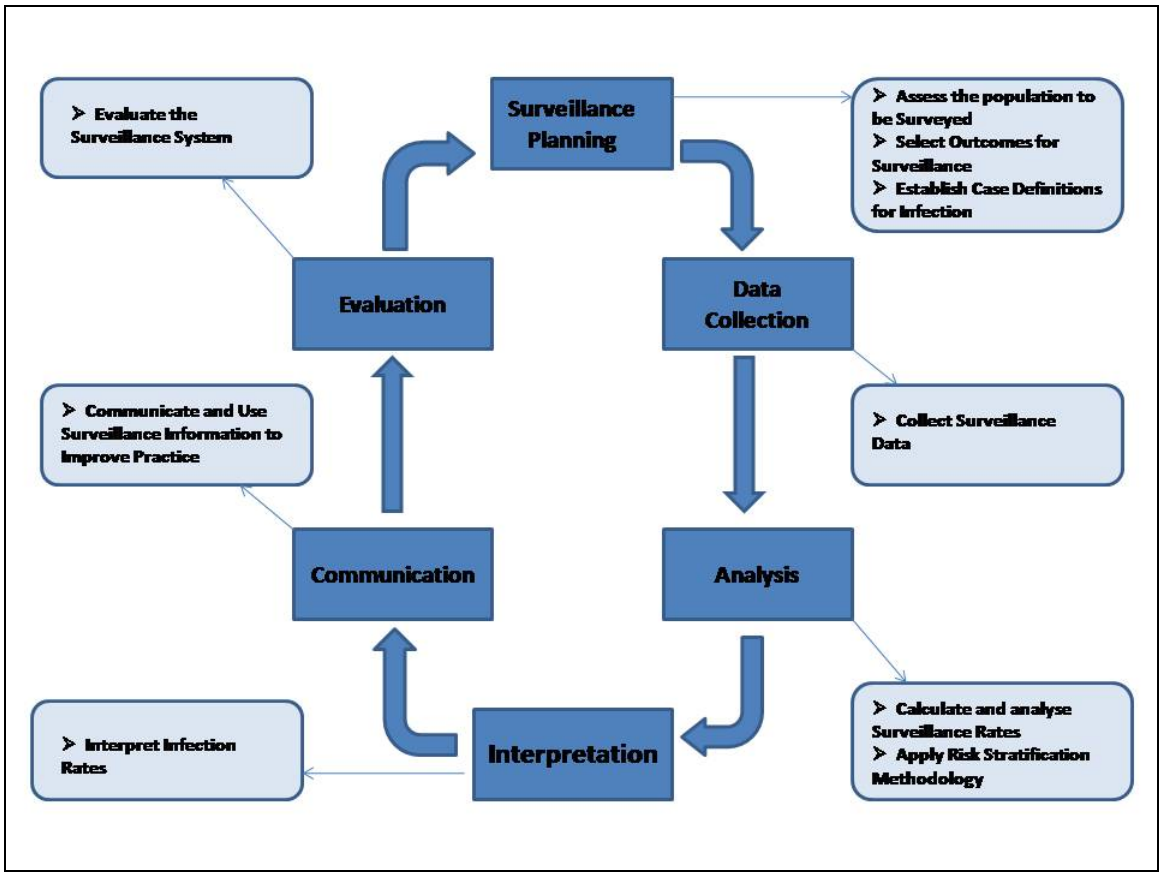


Figure 1: Steps to Planning a Surveillance System

Step I: Assess the Population to be Surveyed

As each health care setting serves different types of patients who face varying levels of risk for different types of infections, an evaluation of the populations served by the hospital or long-term care home should be a first step in planning a surveillance system. This evaluation enables priorities for a surveillance system to be established. Resources for surveillance can be then targeted to the populations at risk for the outcomes of greatest importance, defined in these priority areas.

How to Assess the Population Served by a Health Care Setting

Box 3 outlines the types of questions that can assist in the assessment of a patient population:

Box 3: Questions Assisting in Assessment of Populations Served by a Particular Hospital or Long-term Care Home

- *What is the catchment area of the hospital or long-term care home?*
- *What types of patients/residents are served (e.g. age distribution, sociodemographic profile)?*
- *What are the most common diagnoses?*
- *What are the most frequently performed invasive procedures (e.g. surgeries for hospitals, indwelling urinary catheters for long-term care homes)?*
- *Which services or treatments are utilized most frequently?*
- *What types of patients/residents are at greatest risk of infection?*
- *Are there any health concerns emerging from the community (e.g. community-associated MRSA, tuberculosis)?*

The use of information resources specific to a particular hospital or long-term care home should be used to address these questions. Examples of some of the information resources that may be used to assess a population include:

a) medical records;
b) financial services or information services reports;
c) surgical databases;
d) administrative/management reports; and
e) community health status reports, produced by local public health units (to identify health concerns from the surrounding community).

Information on the demographic characteristics of the population served by a health care setting, such as its age distribution, socioeconomic conditions and ethnic diversity, can be obtained from the health care setting's census reports.

Recommended Practice 1.0: As a first step in the planning of a surveillance system, it is a recommended practice that a health care setting assess:

- the types of patients/residents that it serves
- the key medical interventions and procedures that they undergo
- the types of infections for which they are most at risk

This assessment is done to establish priorities for the surveillance system.

Step II: Select the Outcomes for Surveillance

Selection of the types of infections that will be surveyed should be undertaken in conjunction with an assessment of the population and identification of surveillance priorities as described above. Most infection prevention and control programs have prioritized the types of infections for surveillance that have the most important impact on the populations that they serve.

1. Facility-wide Surveillance

Facility-wide surveillance of all infections is not recommended in health care settings. Facility-wide surveillance involves the prospective and continuous survey by the ICP (or the person to whom responsibility for surveillance has been designated) of all care areas of the hospital or long-term care home for all instances of infection. The ICP also follows

up frequently with nursing and other staff (daily, if possible) and occasionally with patients/residents in all areas of the health care setting. Facility-wide surveillance, while comprehensive, requires considerable time and personnel resources. There is no value to identifying infections for surveillance purposes unless the results may be used to effect change that will result in lower HAI rates. Facility-wide surveillance will identify many infections that cannot be prevented, wasting valuable resources that may be used for other purposes, such as education. Prioritization of the types of infections to be surveyed will assist the ICP to make the best use of the available resources while having the greatest impact on the populations that they serve.

Pearl of wisdom: Health care settings will not find it feasible to conduct surveillance of all infections in all patients/residents at all times. Prioritization of the most important infections to be included in a surveillance system will be necessary.

2. General Determinants for Surveillance Choices

The choice of which infections to monitor by surveillance may be determined by several factors:

a) the health care setting may be mandated to monitor specific infections (e.g. required for accreditation review or to comply with PIDAC's recommended best practices[1]);
b) a particular type of infection may be of special concern in the health care setting due to its frequency;
c) a particular pathogen may be of concern in the health care setting due to its communicability;
d) the infection has associated impacts and costs indicated by:
    i. the frequency with which the infection results in mortality (its case-fatality ratio);
    ii. prolonged hospital stay resulting from the infection;
    iii. issues with transfers to non-hospital settings; and
    iv. the excess treatment costs associated with the infection;
e) surveillance for a particular infection will assess the effectiveness of infection prevention and control interventions; and
f) syndromic surveillance (e.g. febrile respiratory Illness (FRI) or respiratory symptoms indicative of an infectious process, acute gastrointestinal (GI) illness) is universally recommended in hospitals and long-term care homes and has the added benefit of detecting important health care-associated infections such as CDAD.

Boxes 4 and 5 illustrate how different types of health care settings may undertake the population assessment and selection of outcomes for surveillance programs:

Box 4: Population Assessment and Selection of Surveillance Outcomes (acute care example)

- *City General Hospital is a fictitious 550-bed tertiary care facility serving a wide catchment area that includes several surrounding rural communities. City General hospital houses a regional cancer centre and trauma centre and serves some of the region's most critically ill patients. City General Hospital targets high risk patients and undertakes surveillance of all patients in the ICU for two types of device-associated infections:*
  - *ventilator-associated pneumonias; and*
  - *central venous catheter-associated bloodstream infections.*
- *Total hip and knee replacements, laminectomies and coronary artery bypass grafts (CABG) are among the most common surgical procedures undertaken at City General Hospital. These have been selected for surveillance due to the severe complications associated with surgical site infection following these procedures. Also, with the presence of the cancer centre, colectomies and abdominal hysterectomies have also been selected for surgical site infection surveillance.*
- *With its wide catchment area and the critically ill patient groups that it serves, City General Hospital also tracks the frequencies of both colonization and infection with antibiotic resistant organisms (AROs).*

Box 5: Population Assessment and Selection of Surveillance Outcomes (long-term care example)

- *Forest Manor is a fictitious 100-bed long-term care home. Half of all residents are dependent on staff for assistance to carry out normal activities associated with daily living.*
- *Symptomatic urinary tract infections (UTIs) comprise one-third of nosocomial infections and 10% of residents have urethral catheters. Lower respiratory tract infections account for half of the remaining nosocomial infections. Approximately 20% of infections developed by residents at Forest Manor are skin and soft tissue infections.*
- *Forest Manor conducts surveillance of lower respiratory tract infections, skin and soft tissue infections and UTIs associated with indwelling catheters. Forest Manor also tracks the percentage of residents receiving annual influenza vaccine to assess how vaccine uptake correlates with lower respiratory tract infections in the resident population.*

3. Selection of Outcomes in Acute Care

What tools can be used to assist in selecting the outcomes for surveillance?

Table 1 illustrates a hypothetical set of data on the frequency, impacts, costs and preventability of four common health care-associated infections in a fictional hospital. The data presented in Table 1 can be collected as a first step in surveillance planning through the use of a prevalence survey.

A *prevalence survey* is a surveillance tool that takes inventory of all active (existing and new) infections at a single point in time. Data from each patient are collected only once, on a single day or over the course of a set number of days.

Table 1: Sample Hospital Dataset Used to Assist With Prioritization of Health Care-associated Infections Selected for Surveillance

The example data below could be used to frame thinking about the infections selected for monitoring. Surgical site infections constitute a substantial proportion of the nosocomial infections presented here, entail extended duration of hospital stay and increase health care costs. A considerable proportion of these infections are also preventable. The hospital may use the data presented in the table below as a basis for prioritization (or continued prioritization) of surgical site infections in its allocation of surveillance resources through intensive surveillance activities. Also, if a hospital wished to expand its surveillance activities into new areas, the data could be used to identify the infections where surveillance would likely have the most impact.

Data used for prioritization of nosocomial infection surveillance in a fictional hospital

Type of Infection	% of all nosocomial infections	% extra days hospitalized due to infection	% extra costs due to infection	% of preventable infections
Surgical Site Infection	24	57	42	35
Pneumonia	10	11	39	22
Urinary Tract Infection	42	4	13	33
Bacteremia	5	4	3	32

A hospital may select its surveillance outcomes based on other factors that are important to the facility. For example, a hospital facing frequent acute care bed shortages may rank infections resulting in prolonged hospital stay as an effective allocation of surveillance resources.

Once selected, a hospital's infection outcomes and associated resource allocations in surveillance are not necessarily fixed. For example, based on the data in Table 1, the hospital may not choose to routinely undertake surveillance of urinary tract infections (UTIs), but may still monitor this type of infection through reviews of urine culture test results from laboratory reports, looking for detection of unusual trends or clustering of cases. Changes in the population served by a hospital, the services it offers, or the changing epidemiology of a particular pathogen may change the risk of acquiring specific health care-associated infections and prompt a reassessment of surveillance objectives and a re-allocation of surveillance resources. Surveillance objectives should be re-evaluated as needed, at least annually.

4. Selection of Outcomes in Long-term and Chronic Care

In long-term care homes, preventable infections may significantly influence the choice of outcomes for surveillance:

a) **Acute respiratory infection/febrile respiratory infection:** In long-term care homes, lower respiratory tract infections, such as influenza, are associated with high morbidity, mortality and disruptions to long-term care services.[42] Surveillance for acute respiratory infection in residents of long-term care homes is universally recommended.

b) **Skin and soft tissue infections:** Another important constituent of the burden of health care-associated infections in long-term care homes is skin and soft tissue

infections.[18] Many of these infections are preventable, particularly where they result from skin breakdown and pressure ulcer development. Consideration should be given to monitoring skin and soft tissue infections, a common quality of care indicator used in acute, long-term and chronic care settings. Surveillance of skin breakdown provides an opportunity for collaboration of health care providers with the infection prevention and control team to reduce the incidence of soft tissue infections.

c) **Urinary tract infection:** In long-term and chronic care settings, many UTIs may be prevented through the limited use of indwelling urinary catheters. These infections form a large part of the burden of health care-associated infections in long-term care homes and may form an important part of the surveillance system.

Recommended Practice 2.0: Syndromic surveillance of respiratory infections and gastroenteritis should be undertaken in all hospitals and long- term care homes.

Where hospitals and long-term care homes select outcomes for surveillance in addition to the infections listed above, the following should be considered:

- the frequency of the infection
- the impacts of the infection (including percent case fatality and excess costs associated with the infection)
- the preventability of the infection

In both hospitals and long-term care, the outcomes selected for surveillance should be re-evaluated at least annually.

Step III: Establish Case Definitions for Infection

In any surveillance system, all elements of the data that are being collected need to be clearly defined, including the infection outcome, the '*at risk*' population and other risk factors for infection. This section outlines the recommended best practices in choosing a case definition for infection.

1. Case Definitions for the Hospital Setting

The NNIS/NHSN program's case definitions are used widely in hospital surveillance programs worldwide. The NNIS/NHSN case definitions for urinary tract infections, bloodstream infections, pneumonias and other infections are provided in Appendix B.

It is a recommended best practice that hospitals use the NNIS/NHSN case definitions for surveillance purposes. The use of these definitions allows for comparability of findings and benchmarking with other similar hospitals that also use the NNIS/NHSN definitions. Hospitals participating in the Canadian Nosocomial Infection Surveillance Program (CNISP) also use case definitions that have been developed for that program. Benefits to using established, standardized case definitions include:

a) The validity and reliability of the NNIS/NHSN case definitions have been well established.[43] If hospitals choose to develop their own case definitions, they will not have the benefit of using definitions that have been reviewed and validated.
b) If a hospital uses its own definitions and at a future date decides to switch to the NNIS/NHSN definitions, the new data will no longer be comparable to previous rates calculated using the earlier case definitions.
c) Hospitals that are similar in size and care level and that use the same case definitions can pool their data to investigate risk factors for infection or practices

that may be effective in preventing nosocomial infections. This is particularly useful when there may be an insufficient number of cases within a single health care setting to provide meaningful results.

Pearl of wisdom: Hospitals using the NNIS/NHSN case definitions benefit from:

- a set of definitions that have been reviewed and validated; and
- surveillance data that can be compared to or pooled with other similar hospitals using the same case definitions

Box 6 provides an example of the case definitions chosen by a fictitious hospital:

Box 6: Establishment of Case Definitions (acute care example)

City General Hospital conducts surveillance for primary bloodstream infections associated with the use of central venous catheters (CVC) and for ventilator-associated pneumonias among ICU patients. The NNIS/NHSN case definitions are used to allow for comparison of findings and benchmarking with other similar hospitals involved in the regional nosocomial infection surveillance program. Patients eligible for this surveillance are adult ICU patients with one or more CVCs and/or patients on ventilator support.

2. Case Definitions for the Long-term Care Setting

Case definitions have been developed by a Canadian Consensus Conference for use in long- term care homes.[44] These definitions were developed taking into account the unique limitations of long-term care surveillance (e.g. lack of radiology and microbiology data). The case definitions for long-term care are presented in Appendix C. It is a recommended best practice that the case definitions from Appendix C be incorporated into surveillance programs in the long-term care setting.

Box 7 provides an example of the case definitions chosen by a fictitious long-term care home:

Box 7: Establishment of Case Definitions (long-term care example)

Forest Manor conducts surveillance for UTIs associated with indwelling catheters and uses the published long-term care definitions for UTI, which include only symptomatic infections. Forest Manor also undertakes surveillance for skin and soft tissue infections and lower respiratory tract infections and uses published long-term care definitions for these, which are based on signs and symptoms of infection.

Recommended Practice 3.0: Hospitals should use the NNIS/NHSN case definitions for nosocomial infections provided in Appendix B. Long-term care homes should use the Canadian Consensus Conference definitions for health care-associated infections in long-term care provided in Appendix C.

3. Applying Case Definitions

Once case definitions have been established, steps should be taken to ensure that they are consistently applied. The case in Box 8 illustrates the potential consequences of inconsistently applied case definitions:

Box 8: Consequences of Inconsistently Applied Case Definition for Nosocomial Infection

- *In a U.S. community hospital, a surgeon was repeatedly investigated by the hospital's infection control team searching for explanations for an elevated infection rate among patients undergoing laminectomy. The surgeon was prepared to discontinue his practice when strict attention to infection control procedures did not result in a decrease in the rates of infection.*
- *Upon further examination it was found that the surveillance case definition used to collect data on the surgeon's patients included all those who had a positive culture, with or without symptoms of infection. For other surgeons, the case definition required positive cultures plus clinical signs of infection. Hence, patients who were only colonized with bacteria had been included in this surgeon's rate of infection, making it appear high.*
- *The high rates of infection were deemed the result of surveillance error, not of poor operative technique, and the surgeon did not abandon his practice. This case emphasizes the importance of uniform application of case definition.*

Ehrenkranz NJ, Infect Control Hosp Epidemiol 1995

4. Ensuring that Case Definitions are Consistently Applied

Infection control professionals should receive training in the consistent and correct application of case definitions for surveillance. Periodically, the reliability in application of case definition among ICPs should be assessed. This can be accomplished by having ICPs independently apply case definitions to a set of potential infections. Subsequently the inter-rater reliability, or proportion of cases deemed indicative of infection by both ICPs, can be assessed. See Step IX, "*Evaluate the Surveillance System*" for more information about reliability testing.

Recommended Practice 4.0: Hospitals and long-term care homes should take steps to ensure that case definitions are consistently and accurately applied.

5. Determining if an Infection was Associated with Health Care ("*nosocomial*")

When a particular infection meets a case definition, it should only be considered nosocomial if it was not present or incubating when the patient/resident was admitted to the hospital or long-term care home. The following criteria may assist in determining if an infection is associated with health care:

a) An infection is not considered nosocomial if it represents a complication or extension of an infectious process that was present at admission.
b) Infections that occur more than 48 to 72 hours after admission, and within 10 days following discharge, are considered to be associated with health care.
c) In long-term care homes, in order for an infection to be considered nosocomial:
    i. There must be no evidence that the infection was present on admission to the facility or readmission (following hospitalization or community visit); and
    ii. There must be no evidence that the infection resulted from a procedure performed at an acute care hospital or in a physician's office.

Determining whether an infection was associated with the care received within the health care setting can represent a major challenge for long-term care homes where residents regularly attend day programs or other activities in the community. When there is uncertainty about whether the infection occurred in community or the long-term care home, the ICP should count a case as "nosocomial".

Many bacterial infections typically become apparent within 48 hours following infection.[45] This general timeframe is modified for bacterial or viral infections known to have shorter (e.g. Norwalk virus) or longer (e.g. Hepatitis C) incubation periods. Because the incubation period varies by pathogen and, to some extent, the underlying condition of the patient, it is necessary that each infection be assessed individually for its links to hospitalization or, for long-term care residents, the likelihood that the infection was acquired within the long-term care home.

Pearl of wisdom: Hospitals and long-term care homes must consider the incubation period for a particular infection and the likelihood that it was acquired in the health care setting when deciding whether a particular case is nosocomial.

Step IV: Collect the Surveillance Data

The goals and outcomes of the surveillance system and the case definitions established in the previous section will determine the data required by the surveillance program. Health care-associated infections are expressed as a rate, i.e. the number of cases as well as the number of persons at risk over a particular period of time. Three elements are required to generate these HAI rates:

a) the number of cases (i.e. persons developing a particular infection);
b) number of persons at risk (i.e. population at risk for development of that infection); and
c) the time period involved.

Because health care settings will have differing priorities for surveillance and resources available to them, case finding may vary from facility to facility. The following procedures provide a guide that may be followed when collecting the data required for the surveillance program based on its objectives and available resources:

a) Review and select sources of data/information for the numerator (number of cases) and denominator (number of persons at risk).
b) Assess the *sensitivity* and *specificity* of the data sources and maximize these two parameters.
c) Choose the most feasible surveillance system for the health care setting.
d) Implement the data collection system.
e) Review the information to ensure the dataset is complete (e.g. ensure that a particular physician or service does not forget to report their cases).

1. Review and Select Sources of Data/Information for the Numerator and Denominator

The infection prevention and control team should examine the sources of data available to them and select the method(s) of case finding that will provide all of the information required for the case definitions that it has selected for use in its surveillance system. Most established case definitions for health care-associated infections, such as NNIS/NHSN or Canadian Consensus Conference case definitions, require a combination of both clinical information (i.e. signs and symptoms of an infection) and diagnostic information (e.g. laboratory results, radiological data) on the patient/resident.

Numerator Data Collection in Hospitals

What sources of data are available for case finding in hospitals?

Sources of data that are commonly used for case finding in the acute care setting with their associated benefits and limitations are presented in Table 2.

Total chart review is not recommended as a case finding method in acute care settings due to the significant time required to obtain data. Different sources of information should be strategically combined to quickly identify potential infections, then further investigation and follow-up is conducted to confirm infection through total chart review and/or consultation with physicians.

Table 2: Sources of Data/Information for Case Finding

Data Source	Methodology	Benefits	Limitations	Resources Required
Total chart/medical record review	▪ ICP reviews medical and nursing notes, medications, treatment records, radiology and laboratory reports for each patient 1-2 times per week for signs of infection (e.g. antibiotics or intravenous fluids	▪ Most complete method of case finding ▪ May be done prospectively or retrospectively	▪ Time consuming (requires 10-30 minutes per record) ▪ Unable to identify all infections due to: o Missing data, diagnostic reports o Record	▪ Additional ICP resources may be required

Data Source	Methodology	Benefits	Limitations	Resources Required
	ordered, special orders for wound dressing, orders for isolation precautions)		unavailable at time of review o May be difficult to confirm that criteria for infection have been met	
Laboratory reports	▪ ICP reviews daily laboratory reports for positive culture results that prompt investigation of potential nosocomial infections ▪ Significant results 'flagged' in electronically-generated batch reports ▪ Laboratory staff notify ICP with significant results	▪ Quickly identifies significant increases in some types of infections ▪ Often identifies microorganisms of special concern before any other method (e.g. MRSA) ▪ ICPs who visit the laboratory frequently will develop rapport with staff, leading to better cooperation and understanding of each other's roles	▪ Infections are missed if cultures are not sent or if microorganisms fail to grow on culture media ▪ Infections are missed if diagnosis is based on signs and symptoms alone. ▪ False positive infections if laboratory-based surveillance is used alone (patient may only be colonized with a microorganism such as MRSA)	▪ Electronic laboratory information system beneficial ▪ ICPs must work closely with the laboratory that services their hospital to develop reporting mechanisms from the laboratory to the ICP
Nursing Kardex/Patient Profile	▪ ICP reviews nursing Kardex/patient profile for each patient 1-2 times per week for signs of infection (e.g. temperature charts, intravenous fluids, antibiotics given, application of Additional Precautions)	▪ Prospective surveillance ▪ Quickly identifies patients suspected of having an infection that require a more detailed review ▪ May identify early signs and symptoms indicative of an outbreak	▪ Relies on accuracy and completeness of the Kardex/Patient Profile for information ▪ Information must be confirmed with a review of the medical record	
Clinical ward/unit rounds	▪ ICP joins patient care staff during clinical rounds, entering into discussions and information sharing regarding potential	▪ Prospective surveillance ▪ Increases ICP visibility in patient care areas ▪ Provides ICP	▪ Time-consuming	▪ Additional ICP resources may be required

Data Source	Methodology	Benefits	Limitations	Resources Required
	infections that may not be included in patient records until a definitive diagnosis has been made.	with the opportunity to monitor patient care practices ▪ Provides opportunity for discussion and informal education on infection prevention and control issues ▪ May hasten the application of Additional Precautions when communicable infections are suspected		
Sentinel reporting system	▪ Patient care staff complete forms documenting possible indicators of infection (e.g. fever, symptoms of respiratory infection, unexplained GI illness). ▪ Patient care staff complete and provide these forms on a routine, often daily, basis	▪ Prospective surveillance ▪ Provides an alert system for outbreaks ▪ Refer to Appendix D for a sample sentinel surveillance form for completion by ward/unit staff	▪ Relies on ward/unit staff taking time to complete forms ▪ Relies on accuracy of ward/unit staff in completing foms	▪ May require additional ward/unit resources
Electronic screening of patient records	▪ Case finding via searches of medical record databases (‘*data mining*’) is an emerging tool for surveillance ▪ Patient records are flagged via algorithm for indicators of nosocomial infection	▪ Effective means to identify post-discharge surgical site infections[46] ▪ Uses include surgical site infections, UTIs and CVC-associated bloodstream infections[47-50]	▪ Results must be verified for accuracy ▪ Relies on accuracy of information that has been entered into the electronic database	▪ Require sophisticated electronic information systems with the ability to create specialized searches and access of ICPs to results

Electronic Information Systems

Electronic identification of nosocomial infections has the potential benefit of decreasing the amount of time spent on data collection, by limiting the number of cases that would be followed by an ICP to those with a high likelihood of infection. Case finding via computer algorithm may result in more of the ICP's time being devoted to prevention, rather than to data collection.

As computerized medical information systems become established in hospitals and long-term care homes, the participation of infection prevention and control professionals in the planning stages, when designing the computerized database, will ensure that the necessary structures and fields for electronic screening for nosocomial infections have been included. The following inclusions to the electronic patient record will assist in identifying potential health care-associated infections:

a) positive laboratory cultures
b) imaging results
c) details of antibiotic use from the hospital pharmacy
d) electronic fields indicating whether a patient has an indwelling urinary catheter, a central venous catheter, or is on a ventilator

While electronic screening of patient/resident records has the potential to increase the efficiency of case finding, caution is advised in the use of this tool. General '*data mining*' can be an oversensitive tool, resulting in investigation of an excessive number of flagged cases that do not meet the case definitions for infection. Very clear indicators for infection should be incorporated into the search mechanism when setting up a system of electronic screening for infection. For instance, some electronic screening systems for post-discharge surgical site infections have been able to flag cases by placing certain dosage and duration parameters on antibiotics as an indicator for infection in order to separate therapeutic from prophylactic treatments.[49] Incorporation of threshold limits into the electronic screening process is an additional tool that will assist the ICP by indicating when there is an increase above the facility's baseline rate of infection.

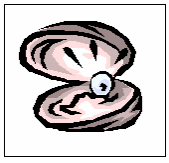
Numerator Data Collection in Long-Term Care Settings

What sources of data are available for case finding in long-term care homes?

The wide range of sources of information that are available in acute care to identify infections is not typically available in the long-term care setting (e.g. regular laboratory reporting, nursing Kardex/patient profile). As a result, case finding in long-term care settings will rely more heavily on feedback from those directly involved in resident care.

Sources of data that are commonly used for case finding in the long-term care setting include:

a) regular ward visits by the ICP;
b) sentinel surveillance sheets, completed by staff on the wards and collected regularly (these provide an excellent mechanism for feedback from the staff regarding potential infections)



Pearl of wisdom: Don't forget the denominator!

Collecting Information for the Denominator

A surveillance rate includes the number of cases (numerator component) developing in the population at risk (denominator component). Therefore, a surveillance system must be able to collect data on the overall population at risk for acquiring health care-associated infections, as well as the individual patients/residents who actually acquire the disease.

For example, for device-associated infections, the population at risk includes the total number of patients/residents exposed to a particular device (e.g. ventilator, central venous catheter, indwelling urinary catheter) during the time period selected for surveillance (e.g. month, quarter). For surgical site infections, the population at risk includes all patients who had the same operative procedure. Additional guidance on rate calculation is provided in Step V, "*Calculate and Analyse Surveillance Rates*".

2. Assess the Sensitivity and Specificity of Sources of Surveillance Data

A surveillance program should consider two evaluative criteria applicable to any case finding method: sensitivity and specificity.

a) *Sensitivity* is the overall proportion of true nosocomial infections that are detected by a case finding method (i.e. the number of true infections occurring in a population divided by the number of infections detected by a case finding method).
b) *Specificity* of a case finding method describes its ability to correctly exclude infections that are not present (i.e. the proportion of true non-infected patients/residents designated as not having an infection by a case finding method).

Using 2 x 2 Tables to Calculate Sensitivity and Specificity

	Infection	No infection
Meets case definition	a	b
Does not meet case definition	c	d

$$\text{Sensitivity} = \frac{a}{a + c} \qquad \text{Specificity} = \frac{d}{b + d}$$

The following example may be used to illustrate ways to calculate the sensitivity and specificity of a case definition:

> Example: On a special care unit with 11 ventilated patients, 3 patients have a ventilator-associated pneumonia (VAP). Only two of the three patients meet the case definition for VAP that the ICP has developed, but two patients without a VAP also meet the case definition. The sensitivity and specificity of the case finding method may be illustrated with a 2 x 2 table in this way:

	VAP	No VAP
Meets case definition	2	2
Does not meet case definition	1	6

Sensitivity = $\frac{2}{3}$ = 0.67 Specificity = $\frac{6}{8}$ = 0.75

= $\frac{\text{\# true positives}}{\text{\# detected}}$ = $\frac{\text{\# true negatives}}{\text{\# not detected}}$

Figure 2 illustrates a way to demonstrate the assessment of sensitivity and specificity for the example above. Ideally, a case finding method will have both a high sensitivity and specificity, i.e. it is able to detect a high percentage of all infections, while at the same time identifying only cases with a high likelihood of actual infection. A relatively high specificity is desirable so that the time that an ICP spends confirming an infection is minimized.

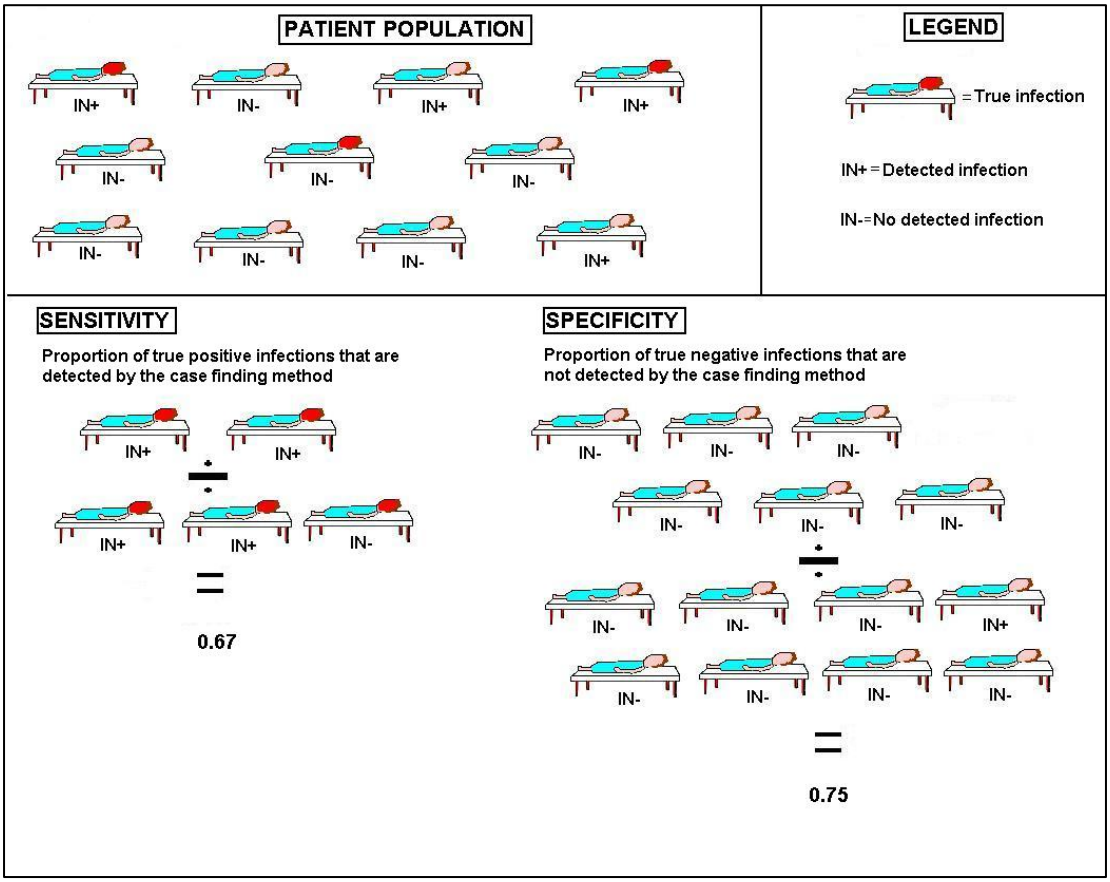


Figure 2: Calculating sensitivity and specificity of sources of surveillance data

Table 3 summarizes the sensitivity and specificity of total chart review relative to other sources of data for case finding The ICP resources required for each of these cases finding methods are also shown in this table. Table 3 demonstrates that similar or higher levels of sensitivity for case detection can be obtained through less resource-intensive case finding methods when compared to total chart review.

Once the data sources that are available to the health care setting have been identified, the sources should be ranked according to their estimated sensitivity (see Table 3). Final selection of data sources to be used for each type of infection that is surveyed will be based on those that have the highest sensitivity and specificity and that are the most feasible to implement in the health care setting.

Table 3: Sensitivity of Various Case Finding Methods and Associated ICP Resources Required for Implementation in Acute Care[51]

Case Finding Method	Data Source	Sensitivity	Estimated ICP Time / 500 Beds (hours)
Total Chart Review	Review all patient medical records	0.74-0.94	35.7-53.6
Selective Chart Review based on:	Only those medical records selected by screening:		
Laboratory Reports	Microbiology reports to identify patients with positive cultures	0.77-0.91	23.2
Kardex Screening	Patient Kardex to determine patients at high risk for infection	0.75-0.94	14.3-22.3
Laboratory-based Ward Liaison Surveillance	Microbiology reports to identify patients with a positive culture and patients reported by nursing staff to have an infection	0.76-0.89	31.8
Infection Control Sentinel Sheet System	"Sentinel Sheet" to identify patients reported by nursing staff to have symptoms of infection	0.73	****
Risk Factor Based Surveillance	Nursing reports and medication records to identify patients with risk factors for infection	0.50-0.89	32.4
Ward Liaison Surveillance	Patients reported by nursing staff to have an infection	0.62	17.6
Antibiotic Use	Medication record to identify patients receiving antibiotics	0.57	14.3
Fever	Temperature record to identify patients with temperature >37.8ºC	0.09-0.56	8
Fever and Antibiotic Use	Temperature record to identify patients with fever >37.8ºC, and medication record to identify	0.70	13.4

Case Finding Method	Data Source	Sensitivity	Estimated ICP Time / 500 Beds (hours)
	patients receiving antibiotics		
Readmission	Admission record for patients readmitted with infection	0.08	Not specified
Autopsy Reports	Autopsy reports to identify patients with infections	0.08	< 0.53

3. Choose the Most Feasible Surveillance System for the Health Care Setting

The approach to case finding should satisfy all information requirements of the surveillance program, while at the same time be feasible in the context of the infection prevention and control program's resources.

Active Surveillance vs. Passive Surveillance

The surveillance system or approach that will be used in the health care setting must be determined and a decision made as to whether it will be involved in active or passive surveillance:

a) *Active surveillance* involves actively seeking out health care-associated infections on a regular basis by individuals trained in surveillance, usually ICPs:
   i. ICP seeks out possible health care-associated infections on a regular basis (e.g. several times per week) using a variety of data sources
   ii. ICP determines whether an infection meets the criteria for a health care-associated infection based on the standardized case definitions
   iii. Requires a high level of ICP effort and resources to be effective
b) *Passive surveillance* involves reliance on staff to provide infection information to the ICP:
   i. patient/resident care staff report infections or suspected infections to the ICP
   ii. requires the least amount of ICP time and resources but is the least sensitive system

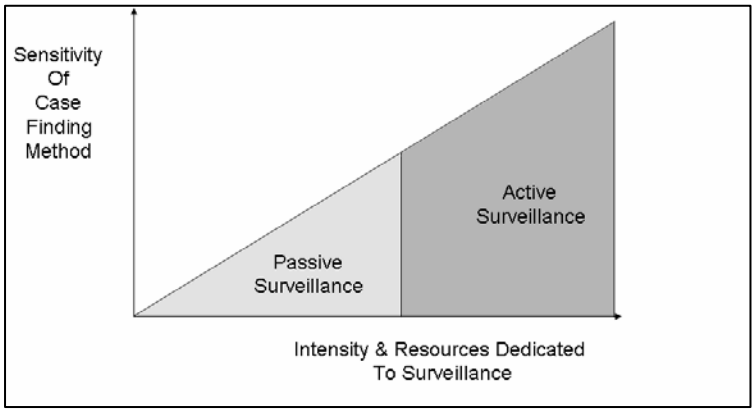


Figure 3 illustrates that the sensitivity associated with active and passive surveillance is directly proportional to the intensity of the surveillance activities involved.

Figure 3: Intensity of resources associated with active and passive surveillance

Passive surveillance systems may be associated with higher levels of misclassification and underreporting of health care-associated infections because they rely on information provided from staff whose responsibilities are centered on patient/resident care and who are less familiar with the application of case definitions. These staff may not have time to keep abreast of changes in surveillance procedures, surveillance definitions or clues to infection beyond the ward/unit on which they provide care. As a result, passive surveillance systems may not provide high quality data or timely information on changes in the risk of health care-associated infections.

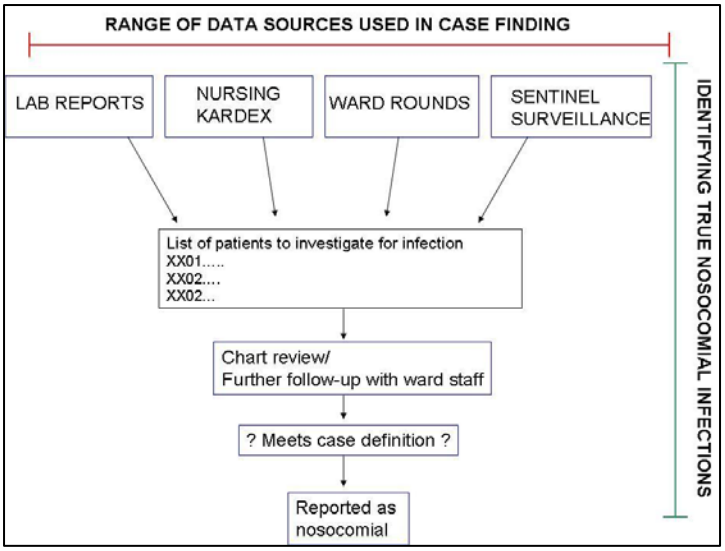
For these reasons, active surveillance is associated with a higher level of sensitivity and is recommended for case finding. Passive surveillance might, however, be the only feasible approach to case finding due to resource constraints. If this is the case, it is critical that education and training is undertaken for patient/resident care staff to ensure that potential infections are identified and that reporting expectations are met.

Recommended Practice 5.0: Active surveillance is a recommended best practice for surveillance programs in hospitals and long-term care homes because of the higher sensitivity associated with this approach to case finding.

4. Implement the Data Collection System

The range of information source(s) used to screen for nosocomial infections can assist in establishing the thoroughness of a case finding method. Health care settings that draw on a wide range of sources for information will detect a greater number of infections.

Once the surveillance system has been defined in terms of its case definitions, sources of data and method of data collection, the data that is being received must be "*cleaned*" or assessed for accuracy and validity. Further investigation of cases that were initially identified as infections requires full chart review and follow-up with patient/resident care staff. This will exclude cases that do not fully meet the case definition for infection.



The process for identifying potential infections that require further follow up is illustrated in Figure 4.

Figure 4: Identification and follow-up of potential health care-associated infections

Boxes 9 and 10 present examples of case finding and data collection in a hospital and a long-term care home:

Box 9: Case Finding and Data Collection (acute care example)

- *The ICPs at City General Hospital conduct active surveillance. Each ICP is responsible for undertaking surveillance in a particular patient care area.*
- *To identify nosocomial infections, the ICPs first undertake a daily review of hospital laboratory reports to identify positive culture results that might indicate infection.*
- *From this laboratory report, the ICP formulates a list of potential infections in his/her assigned patient care area.*
- *The ICP then visits the nursing units for follow-up of the positive cultures and for identification of additional potential infections through discussions with unit nurses and notes on patient profiles ('Kardexes').*
- *From these data sources, the ICP develops a full list of potential infections to be confirmed through more detailed chart review and consultation with clinicians.*
- *The form below assists the ICP in organizing the information collected:*

Potential infections for investigation

Date: _____ Patient care area:_____

Patient ID	Source of data (check all that apply)				Indication of possible infection (e.g. + cultures, fever, antibiotics, new orders for precautions)	Findings from chart review	Findings from discussion with patient care staff
	Lab Cultures	Ward Rounds	Kardex	Sentinel sheet			
001							
002							
…							

- *For surveillance of device-associated infections (e.g. CVC-associated BSI, ventilator-associated pneumonia), the ICP obtains denominator data (the number of patients exposed to procedures and devices) from the ICU's specialized database.*
- *For surgical site infections, denominator data (total number of patients undergoing the selected surgical procedure) is obtained from the City General Hospital's surgical database.*

Box 10: Case Finding and Data Collection (long-term care example)

- *At Forest Manor, ward nurses complete a form designed by the ICP during each shift, identifying the patients with signs and symptoms of UTI, skin or soft tissue infections, or of lower respiratory tract infections.*
- *The total number of patients with indwelling urinary catheters on a ward is also recorded on the form by nursing staff, so that denominator data can be compiled.*
- *The form shown below is an example that assists the ICP with data collection:*

Infection Control Daily Rounds Date: _____ Ward/unit:_____

Completed by:_____

Patient ID	Residents in ward showing signs and symptoms of lower respiratory infection? (e.g. fever + malaise, sore throat, cough)	Residents on ward showing signs and symptoms of skin/soft tissue infection? (e.g. pus/drainage from wound site, fever + inflammation or soreness at site)	Resident has an indwelling catheter?	Catheterized residents on ward showing signs and symptoms of urinary tract infections? (e.g. change in character of urine and other symptoms of infection)	Outline actions undertaken for any suspected infections (e.g. laboratory tests ordered, precautions)
001					
002					
...					

- *The ICP follows up these residents, discusses them with the ward nurses and applies the pre-established case definitions with laboratory findings in order to classify the case as a confirmed infection, a suspect infection or infection ruled out.*

5. Review the Information to Ensure the Dataset is Complete

One of the challenges with any surveillance system is identifying when data elements are missing. For example:

a) Surgeons may not realize that they are to report surgical site infections seen in the outpatient clinic
b) Staff in an intensive care unit (ICU) may be fully occupied with urgent patient care needs and not complete surveillance forms in a timely fashion

These challenges generally occur over time, after the initial enthusiasm or novelty of the surveillance system wears off. Methods for regularly reviewing the surveillance system include:

a) Audits of the surveillance system to ensure that all data items are being collected and that the dataset is complete; and
b) Assess the timeliness of case documentation by calculating the time from onset of infections to the time when they are entered into the surveillance dataset.

Regular reporting of surveillance information back to the providers of the information (e.g. surgeons in their clinics, staff in ICUs) provides feedback, reminds them of the importance of reporting to the system and allows them to see the results of their input and give the infection prevention and control team comments if they do not understand the results.

Post-discharge surveillance for surgical site infections

Surveillance for surgical site infections (SSIs) should be a key component of a hospital's surveillance system given the severity, high cost and frequency of these preventable infections. With a rapidly increasing trend towards shorter stays and an increasing proportion of surgeries performed in an outpatient setting, the frequency of SSIs becoming apparent post-discharge has inevitably increased.

The proportion of SSIs that develop post-discharge has been estimated at around 50% in several studies,[52-55] but has been reported as high as 84%.[56] An effective surveillance system should include strategies to detect SSIs that develop post-discharge.

Post-discharge surveillance generally involves follow-up with patients or surgeons within a one-month period post-discharge, often via questionnaire or over the telephone, in order to identify potential surgical site infections. However, patient groups have been shown to be unable to recognize SSIs, even when given specific verbal and written instructions.[57] Follow-up both with patients and surgeons for SSIs post-discharge is frequently associated with low response rates.[56] As surgical patients at high risk for infection are less likely to be lost to follow-up, HAI rates might appear to be higher than they actually are when results from low risk patients are not included.

To date there is no generally accepted method for conducting post-discharge surveillance for SSIs outside the hospital setting and no formal recommendation on post-discharge surveillance methodology is possible. There is little evidence on which to base recommendations for one particular case finding method for post-discharge SSIs over another. A review of the literature by Kent et al. found the following methods to be associated with higher response rates to questionnaires sent to surgeons for information on post-discharge SSIs[58]:

a) an enthusiastic and persistent ICP;
b) frequent personal contact by the ICP and other members of the Hospital Epidemiology/Infection Control Committee;
c) "*user-friendly*" data collection sheets (brightly coloured forms with case definitions printed on the back);
d) a reliable free courier for pick up and delivery of surgeon's letters and completed questionnaires;
e) tracking and reminders regarding unreturned questionnaires; and
f) second and third phone calls if the data was not received within the agreed time frame.

Many of these factors require considerable additional time and resources by the Infection Control Team. ICPs are encouraged to develop innovative approaches for the detection of post-discharge SSIs that do not interfere with the time spent on other components of their surveillance system. Examples include:

a) Partner with organizations providing home care services to surgical patients to ensure that post-discharge SSIs that develop in their clients are promptly reported to the hospital's ICP[59];
b) Electronic screening of patient records post-discharge for indications of infection (e.g. return visits to emergency department)[46, 58]; or
c) Readmission flags on hospital databases to detect admission due to infection.

Step V: Calculate and Analyse Surveillance Rates

The steps in data collection described to this point have been focused at the level of the individual patient/resident. Calculating incidence rates involves compiling individual level patient/resident data and then aggregating it into a summary of the risk for developing a nosocomial infection within a population of patients over a specified time period.

Incidence rates are population-level measures where the *numerator* is the infection or event of interest and the *denominator* includes the group of persons in which the infection or event may occur during the time frame of interest, i.e. population at risk for nosocomial infection. A summary sheet on the calculation of surveillance rates is provided in Appendix E.

1. Surveillance Rates Adjusted for Length of Stay

In many health care settings, overall HAI rates are calculated by dividing the number of health care-associated infections identified over a given time period (e.g. per month) by the total number of admissions or discharges in the month. However, overall facility HAI rates may be misleading for several reasons:

a) Patients may be at varying risk of infection because of varying length of stay in a facility.
b) The longer a patient is in hospital the greater the likelihood of acquiring infection.

For example, obstetric ward patients typically have short stays and generally have a lesser risk of developing a HAI. In contrast, ICUs or rehabilitation wards generally have fewer admissions but patients on these wards have longer stays and are at a higher risk of developing a HAI. If the rate of infection was expressed as the number of cases divided by the number of admissions per month, it would likely underestimate the risk of infection on a high turnover, low risk obstetrics ward (because the denominator is inflated) and overestimate it on a low patient turnover, high risk ICU or rehabilitation ward.

Health care-associated infection rates should be adjusted for length of stay, i.e. the number of infections per patient/resident day, in hospitals and long-term care homes. Rates of infection per patient/resident day, also called *incidence density rates*, provide a more accurate estimate of the risk of infection in a particular health care setting.

Incidence Density Infection Rates	
What are they?	A rate of infection that adjusts for varying time at risk for nosocomial infection, in this case, length of hospital stay.
How are they calculated?	By dividing the total number of infections detected by the total number of days that patients spent in hospital over a surveillance period.
What information do they convey?	The risk of nosocomial infection over a particular time period, taking into account varying lengths of stay in hospital by patient.

In some areas of long-term care, such as long-term care homes, resident turnover is generally low, particularly in self- care areas. The resident population is generally fixed and the denominator is relatively constant with the same number of residents contributing the same number of resident days. Adjustment for resident length of stay may not be critical in this context.

However, other areas of long-term care, such as units providing Complex Continuing Care (CCC), will have higher numbers of resident transfers and thus a varying denominator.

The total number of resident days over a given surveillance period is often readily available from a facility's billing department and can be used to calculate a rate of infection expressed in terms of resident days. It is recommended that rates of health care-associated infection be expressed per resident day in order to account for resident transfers in and out of long-term care homes, allowing for more accurate rate comparisons.

Recommended Practice 6.0: It is a recommended practice to adjust rates of health care-associated infection for patient/resident length of stay by using the number of patient/resident days as the denominator, rather than number of admissions or number of beds.

2. Surveillance Rates Adjusted for Type of Procedure in the Hospital Setting

Hospital patients are at varying risk for HAIs depending on the therapeutic interventions that they undergo in acute care. For example, patients undergoing knee arthroscopy are at a lesser risk for surgical site infection than those undergoing colon surgery or coronary artery bypass graft (CABG). These differences in infection risk are due to:

a) the invasiveness of the procedure; and
b) the characteristics of the patients undergoing the procedure.

One way to control for different risks associated with different surgical procedures is to compare patients having undergone the same surgical procedure. The numerator consists of the number of patients having developed a SSI following a specific surgical procedure and the denominator consists of all patients having undergone that same surgical procedure during the same period of time (e.g. in a particular month).

Procedure-specific Surgical Site Infection Rates	
What are they?	A rate of surgical site infection (SSI) specific to an operative procedure.
How are they calculated?	By dividing the total number of surgical site infections that occur during a specific time period following a specific operative procedure by the total number of persons undergoing that operative procedure during that same time period.
What information do they convey?	The risk of SSI associated with a specific type of operative procedure in hospital in a given period of time. The risk of SSI varies according to the operative procedure. Therefore, calculating a rate of infection that is specific to an operative procedure provides a means to control for the varying risks associated with different operative procedures.

NNIS/NHSN provides a list of operative procedure categories and corresponding ICD-9-CM procedural codes (*International Classification of Disease, 9th Revision – Clinical Modification, Volume 3 (Procedures)*[60] that have been developed by the U.S. National Center for Health

Statistics (available online at: http://www.cdc.gov/nchs/about/otheract/icd9/abticd9.htm). These may be used to assist in grouping similar surgical procedures. This list is provided in Appendix F.

Recommended Practice 7.0: It is a recommended best practice to calculate of rates of surgical site infection in patients undergoing the same surgical procedure. Strategies should also be developed to detect surgical site infections post-discharge. There is no generally accepted method for conducting post-discharge surveillance outside the hospital setting.

3. Surveillance Rates Adjusted for Exposure to Medical Devices

Exposure to medical devices, such as ventilators, CVCs, intravenous catheters, enteral tubes and indwelling urinary catheters, is associated with a higher risk of HAI. The longer a patient/resident is exposed to a device, the greater their likelihood of developing an infection. Adjustment for exposure to medical devices is important in both hospitals and long-term care settings. With a growing population receiving complex continuing care, exposure to medical devices such as CVCs (e.g. for dialysis treatments, supportive care) is increasing outside of the hospital setting. In addition, the proportion of long-term care residents with indwelling urinary catheters can exceed 10%.[61]

To obtain a rate that is adjusted for length of exposure to a device, divide the number of device-associated infections by the total number of days that all patients/residents were exposed to the device during the surveillance period. For example:

a) A surveillance program monitoring ventilator-associated pneumonias (VAPs) among ICU patients would calculate the rate of infection by dividing the number of VAPs in ICU patients by the total number of days during which ICU patients were ventilated during the surveillance period (e.g. month).
b) The complex continuing care unit of a long-term care home monitoring central venous catheter-associated bloodstream infections would divide the number of primary bloodstream infections in CCC patients/residents by the total number of days during which CCC patients/residents had a CVC in place during the surveillance period (e.g. quarter).

Device-associated Infection Rates	
What are they?	A rate of infection associated with exposure to a medical device, such as a ventilator, central venous catheter or indwelling urinary catheter.
How are they calculated?	By dividing the total number of infections experienced by patients/residents exposed to a particular device by the total number of days that all patients/residents were exposed to the same device.
What information do they convey?	The risk of health care-associated infection associated with exposure to a particular device over a particular time period, taking into account varying lengths of time that patients were exposed to that device.

Recommended Practice 8.0: It is a recommended best practice to calculate rates of device-associated infection that are adjusted for duration of exposure to the device.

Denominator data for device-associated infections

Obtaining data on the total number of patients/residents at risk for device-associated infection may present a challenge for some health care settings. In some hospitals, special care areas (e.g. the ICU) may maintain their own database on patients where the number of days that a particular patient was exposed to a device is included or can be included as part of data collection. Where device-days are not routinely collected within a patient/resident population, surveillance systems can develop other means for obtaining this data.

What tools can be used for collecting denominator data for device-associated infection rates?

1. Some hospitals and long-term care homes have arranged for health care providers to complete an index card outlining the date that a patient started on a device and the date that this exposure ended. These completed cards can be routinely picked up by the ICP.

Figure 5 illustrates a sample card that may be used by staff for the collection of device-days for CVC- associated bloodstream infection rates.

What tools can be used for collecting denominator data for device-associated infection rates?

2. Another method for collecting information about device-days is to have staff count the total number of patients/residents who are exposed to the device of interest each day and report these figures to the ICP. While this approach will provide the total number of device-days required for the denominator, it does not provide information on how long *each* patient/resident was exposed to a device.

For example, if the ICP is surveying the rate of UTIs associated with indwelling catheters among those over age 65, only the total number of catheter-days will be available using this method of data collection. The number of catheter-days in the over 65 age group cannot be separated from this total for use in the denominator; hence the rate in this age group cannot be calculated. Obtaining the length of time that each patient/resident is exposed to a particular device, rather than the total number of device-days for a patient care area, is ideally recommended as part of data collection for calculating device-associated infection rates.

Recommended Practice 9.0: When collecting data for the denominator for device-associated infection rates, it is a recommended best practice to collect data on the length of time that each patient/resident was exposed to a particular device, rather than the total number of days that all patients were exposed to the device.

CVC-associated BSI? YES __ NO __

Last Name: _____ First Name: _____
HFN _____

Date of Admission: _____ Date of Discharge: _____
Number of Days on Ward/Unit: _____

Central Venous Catheter (CVC) inserted on this ward/unit? YES __ NO (Ward/Unit: _____)

Date first inserted: _____**Type:** _____
Dates changed:
Date: _____ Type: _____
Date: _____ Type: _____
Date: _____ Type: _____
Date: _____ Type: _____

# of positive blood cultures: ____ # taken: ____

CULTURES: **SYMPTOMS:**

Date	Site	Organism	Date	Temp	WBCs	BP	Other:

Figure 5: Sample card for collection of device-days for CVC-associated BSI denominator

Boxes 11 to 14 provide example data sets and calculation of incidence HAI rates for AROs and HAI rates adjusted for exposure to procedures and devices in the fictional hospital and long-term care home.

Box 11: Calculation of Incidence of Device-associated Infection (acute care example)

- *The Infection Control Team at City General Hospital calculates the following infection rates over the quarterly surveillance period. The ICP obtains data on exposure to central lines and ventilators for each patient from the ICU database. These data are demonstrated in the following spreadsheet:*

Patient ID	Date of central line insertion	Date of central line removal	Date of primary bloodstream infection	# of days with central line	Date patient went on ventilator	Date patient was taken off ventilator	Date of onset of pneumonia	# days on ventilator
0001	Jan 21	Feb 7	No infection	14	.	.	No infection	0
0002	Jan 28	March 2	Feb 28	32	.	.	No infection	0
0003	.	.	.	.	Jan 2	Jan 11	Jan 9	10
0004	Feb 1	Feb 13	No infection	12	Jan 15	Jan 31	No infection	15
0005	.	.	.	.	Feb 3	March 4	Feb 25	28
.		.	.	.	.	.	.	.
.		.	.	.	.	.	.	.
.		.	.	.	.	.	.	.
.		.	.	.	.	.	.	.
0080	March 7	March 30	March 30	22	.	.	No infection	10
Total for first quarter:			**8 infections**	**1080 line days**			**4 total infections**	**660 ventilator days**

- *In order to calculate the rates of central-line associated bloodstream infections and ventilator associated-pneumonias, the ICP totals the columns in the spreadsheet above and divides the number of infections by the total number of device days. Rates of nosocomial infection during the surveillance period are shown below:*

Infection outcome	Number of events (numerator data)	Population at risk (denominator data)	Rate of infection
Central line-associated blood stream infection	Primary bloodstream infections among ICU patients on central lines 8	Total number of days that ICU patients were on central lines over year period 1080	Rate of bloodstream infection: = No. events / No. of central line days X 1000 = 8 / 1080 X 1000 = 7.4 per 1000 patient central line days
Ventilator-associated pneumonia	Pneumonias developing in ventilated patients 4	Total number of days that ICU patients were on ventilators 660	Rate of pneumonia: No. events / no. of ventilator days X 1000 = 4 / 660 X 1000 = 6.1 per 1000 patient ventilator days

Box 12: Calculation of Incidence of Surgical Site Infection (acute care example)

The ICP calculates the rates of surgical site infections:

- *The numerator is obtained by totalling the number of surgical site infections following a particular operative procedure*
- *The denominator is obtained by totalling the number of patients having undergone that particular procedure over the quarterly surveillance period, obtained from the hospital's surgical database*
- *Rates of surgical site infection are presented per 100 procedures in the table below:*

Type of surgery	Number of surgical site infections following surgery	Number of patients undergoing surgical procedure per quarter	Rate of infection (No. infections per 100 procedures)
Knee replacement surgery	2	150	Calculation: $\frac{2}{150} \times 100$ = 1.3 per 100 procedures
Hip replacement surgery	4	125	3.2 per 100 procedures
Laminectomy	2	75	2.6 per 100 procedures
CABG	7	250	2.8 per 100 procedures
Colectomy	10	250	4.0 per 100 procedures
Abdominal hysterectomy	4	91	4.4 per 100 procedures

4. How Often are Surveillance Rates Calculated?

For closer monitoring of changes to the risk of acquiring HAIs, many health care settings will calculate rates of nosocomial infections on a monthly basis. It is common practice to calculate HAI rates monthly and summarize and present surveillance data quarterly to facility committees, patient/resident care staff and other stakeholders.

For example, calculating MRSA infection rates on a monthly basis will allows the Infection Control Team to track these microorganisms and respond to the changing risk of infection in a timely manner. Some special care areas, such as ICUs, may also calculate rates of device-associated infections on a monthly basis for faster response to clusters of infection among its highly susceptible patient group.

Box 13: Example Calculation of Incidence of Antibiotic-resistant Organisms (AROs)

- *For the numerator, the ICPs total the number of persons both colonized and infected with MRSA and/or VRE.*
- *As all patients are at risk for colonization or infection with MRSA and/or VRE, the denominator for this rate consists of the total number of patient days among those admitted to hospital during the surveillance period.*
- *Monthly rates of colonization and infection are calculated in addition to quarterly rates, in order to detect increases that will require immediate intervention. The ICPs obtain the number of days that all patients spent in hospital from the hospital's administrative database and totals this to obtain the denominator for both the monthly and quarterly surveillance rates:*

Patient ID	Admission date	Discharge date	MSRA cultures	VRE cultures	Number of days in hospital
0001	Jan 1, 2007	Jan 2, 2007	Negative	Negative	1
0002	Jan 1, 2007	Jan 8, 2007	Negative	Negative	7
0003	Jan 1, 2007	Feb 16, 2007	Positive	Positive	45
0004	Jan 1,, 2007	Jan 16, 2007	Negative	Negative	15
0005	Jan 2, 2007	Jan 7, 2007	Negative	Negative	4
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
4500	Mar 31, 2007	.	Positive	No	15
Total Jan			**35 positive**	**19 positive**	**45,000 patient days**
Total Feb			**40 positive**	**25 positive**	**48,500 patient days**
Total Mar			**37 positive**	**21 positive**	**46,500 patient days**
Total Jan-Mar			**112 positive**	**65 positive**	**140,000 patient days**

- *From this data, rates of MRSA and VRE are calculated by dividing the number of infections/colonizations by the total number of patient days and multiplying by 10,000:*

MRSA	Number of laboratory confirmed cases of MRSA	Total number of patient days in hospital	Rate of infection
January	35	45,000	$\frac{35}{45{,}000} \times 10{,}000$ = 7.8 per 10,000 patient days
February	40	48,500	8.3 per 10,000 patient days
March	37	46,500	8.0 per 10,000 patient days
Total for first quarter:	**112**	**140,000**	**8.0 per 10,000 patient days**

VRE	Number of laboratory-confirmed cases of VRE	Total number of patient days in hospital	Rate of infection
January	19	45,000	4.2 per 10,000 patient days
February	25	48,500	5.2 per 10,000 patient days
March	21	46,500	4.5 per 10,000 patient days
Total for first quarter:	**65**	**140,000**	**4.6 per 10,000 patient days**

The rates expressed in the table above are per 10,000 patient days. The infrequency of MRSA and VRE colonization or infection relative to the total number of days that patients spent in a hospital/long-term care home makes the infection rate expressed per 10,000 patient days more appropriate. Hospitals and long-term care homes should present their rates using the same denominator as that of other health care settings or national benchmarks to which they wish to compare.

Box 14: Calculation of Incidence of Nosocomial Infections (long-term care example)

Example #1: Urinary Catheter-associated UTIs

- *The ICP at Forest Manor collects data on the use of indwelling urinary catheters from the forms completed by ward nurses.*
- *The ICP inputs data from the forms into an electronic spreadsheet and totals the number of catheter days in the resident population and the total number of UTIs in this group:*

Resident ID	Date of catheter insertion	Date of catheter removal	Date of UTI	# Catheter days
0001	Jan 21	March 3rd	March 3	41
0002	.	.	.	.
0003	.	.	.	.
0004	Feb 1	.	No infection	59
0005	.	.	.	.
.	.	.	.	.
.	.	.	.	.
0100	March 7	March 31	March 31	24
Total for first quarter:			**7 infections**	**1790 catheter days**

- *There were 1790 indwelling catheter days at Forest Manor over the quarterly surveillance period and 7 symptomatic urinary tract infections among residents with indwelling catheters. The rate of catheter-associated UTIs is:*

$$= \frac{\text{7 UTIs in residents with indwelling catheters}}{\text{1790 resident catheter days}} \times 1000$$

= 3.9 UTIs per 1000 resident catheter days

Example #2: Lower Respiratory Infections

- *The population at risk for lower respiratory tract infections includes all residents at Forest Manor.*
- *Sixty-one lower respiratory tract infections were identified over the quarterly surveillance period.*
- *As all residents at Forest Manor are at risk for respiratory tract infections, the denominator for this rate is the total number of resident days.*
- *Forest Manor's billing database indicates that there were 16,940 resident days over the quarterly surveillance period. The rate of nosocomial infection is:*

$$\frac{\text{61 lower respirator tract infections}}{\text{16940 resident days}} \times 1000$$

= 3.6 infections per 1000 resident days

Recommended Practice 10.0: Health care settings should use electronic systems to store data and assist with the calculation of HAI rates.

5. Assignment of Nosocomial Infections to Specific Surveillance Periods

Infections are typically associated with the date of onset of symptoms. However, in certain cases, infections identified in the current surveillance period may have resulted from an exposure that took place in the previous surveillance period. This is particularly true for SSIs related to joint surgery, where an infection can take up to one year to develop. Case definitions for health care-associated infections should take these factors into account.

6. How to Organize Data in Electronic Format for Calculation of Rates

The examples in Boxes 11 to 14 show the calculation of HAI rates from data compiled in an electronic spreadsheet/database. It is a recommended practice that all health care settings have a computerized system to track and monitor patient/resident surveillance data. This system should also allow for the analysis of infection data or, at a minimum, allow the data to be exported to statistical analysis software.

Where electronic systems are used to store and analyze data, HAI rates can be calculated with greater ease and efficiency and are less prone to error, provided that the ICP has received training in the use of such programs. Health care settings that do not use specific infection control computer programs should track infections using a spreadsheet or database program. Several simple statistical software packages compatible with most spreadsheet/database programs are currently available. ICPs requiring assistance in setting up an electronic system may be able to contact their facility's information technology staff, local public health unit or Regional Infection Control Network (RICN) for guidance.

7. How to Handle Missing Data

Occasionally a hospital or long-term care home will encounter missing data in the calculation of their HAI rates. Missing data are common when doing post-discharge surveillance for SSIs, as many patients are lost to follow-up and their infection status will be unknown. There are several ways to deal with surveillance results when some of the data are not available:

a) If it is unknown whether a patient/resident developed an infection then this person should be excluded from both the numerator and the denominator in rate calculations.
b) As a general rule, if the number of patients at risk for an infection excluded from a rate exceeds 20% because of missing data, then the validity of the rate may be jeopardized.[62]
c) The rate should be reported with the caveat that "*over X % of patients at risk were excluded from the rate due to missing observations*".
d) Hospitals and long-term care homes should keep track of the type of data that is most frequently missing and enhance efforts to ensure the completeness of the data.

Step VI: Apply Risk Stratification Methodology

Patients/residents served by differing health care settings have differing extrinsic risk factors, related to the treatments and procedures that they undergo, and intrinsic (or patient-related) risk factors for HAI, including underlying disease condition and advanced age. Without adjustment for these factors, comparisons within the same health care setting or inter-facility comparisons may be invalid or misleading.

For example, comparison of rates of infection between a community hospital and a tertiary care hospital may show a substantially higher rate of HAI in the tertiary care hospital. This difference may be due to several factors:

a) Higher degree of susceptibility to nosocomial infection in the more acutely ill population served by the tertiary care hospital;
b) The number of health care workers in direct contact with the patient; and
c) The greater invasiveness of procedures undertaken in the tertiary care setting.

Hence, comparisons between these two hospitals will not be meaningful as the infection risks are very different.

1. Risk Stratification

Stratification is a process to control for differences in the underlying risk factors for infection. Risk stratification involves categorizing patients/residents with similar susceptibilities to infection and calculating the HAI rates based on these groupings. Risk stratification allows for meaningful comparison of rates among patients/residents with similar risks within a health care setting or between health care settings and at different points in time.[63]

Risk stratification in long-term care

Risk stratification of HAIs in long-term care is uncommon, but may provide useful information. For instance, it is recognized that long-term care residents with limited mobility and who require assistance with daily living are at higher risk of lower respiratory tract infection. It is possible that resident mobility could be developed as an indicator of risk of health care-associated respiratory infection in the long-term care setting.

Risk stratification in acute care

Risk stratification methodology is generally applied to surgical site infections and, occasionally, to other types of infections (e.g. neonatal infection rates stratified by birth weight). Rates of health care-associated infection are often stratified by the major non-modifiable risk factors pertaining to that infection.

Surgeries can be classified by wound class, i.e. the likelihood of contamination of the surgical site at the time of the operative procedure:

a) Surgical procedures falling into the clean wound class category (class I) are non-emergency, involve access only to the sterile body sites and carry the lowest risk (e.g. less than 5%) of surgical site infection.[59]
b) Procedures falling into the contaminated wound class (class III) carry a high risk (e.g. 10 to 15%) of infection often because they involve unusual contamination from a non-sterile site (e.g. large bowel resection contaminated with faecal material).

Wound class is often determined by the nature and urgency of the procedure and is not modifiable by changes to infection prevention and control practices. Therefore, stratification of infection rates by wound class allows for the comparison of SSI among procedures that carry similar risks.

Refer to Appendix G for a description of wound classes.

Recommended Practice 11.0: It is a recommended best practice that hospitals stratify rates of procedure-specific surgical site infections by wound class.

2. Using Risk Indices in Stratification

Risk indices are used to combine several risk factors for a particular infection, rather than calculating a separate rate for each of these factors. In selecting a risk index, the ICP should use categories of risk that have been validated for predicting the risk of infection.

Limited progress has been made in developing practical risk indices that have been shown to correlate well with the risk of nosocomial infection. One example, the Acute Physiologic and Chronic Health Evaluation (APACHE II) is a scoring system used to establish severity of illness among ICU patients, which is thought to correlate with the risk of acquiring a nosocomial infection. However, the APACHE system has had limited utility in predicting risk of nosocomial infection because the patients with the highest scores generally do not survive long enough to acquire a HAI.[45] Where a risk index has not been shown to correlate with the actual risk of infection in a health care setting, it will be of little use.

The NNIS/NHSN risk index for SSIs

The U.S. NNIS/NHSN system has developed a risk index specifically for surgical site infections, based on a combination of patient and procedure-related risk factors. The risk factors included in the NNIS/NHSN index are non-modifiable and relate to both the patient and the characteristics of the procedure. The risk index components include:

a) length of the operative procedure;
b) wound class; and
c) the American Society for Anaesthesiologists (ASA) score, which summarizes the extent of underlying illness and functional limitations of a patient.

In this risk index, all patients receive a score from 0 to 3 based on the following characteristics of the patient and the surgery:

▪ Wound class score ≥ 3	1 point
▪ ASA score 3,4,5	1 point
▪ Length of operative procedure beyond 75th percentile cut-off for that procedure	1 point

The NNIS/NHSN risk index score is commonly used as a basis for stratification for SSIs and has the advantage of facilitating comparability of rates of infection with other hospitals, adjusting for risk through the use of this index. The index components (i.e. wound class, ASA score, length of operative procedure) are also easily obtainable from a hospital's surgical database information.

Figure 6 illustrates a sample chart abstraction tool for all patients undergoing cardiovascular surgeries that can be used to gather key data on SSIs and other risk

factors for use in the NNIS/NHSN index. A hospital may find this tool useful when the information cannot be obtained directly from a health care facility's surgical database.

Pearl of wisdom: The information required for risk stratification (e.g. wound class, length of procedure) needs to be collected from *both* the patients developing infections and the patient population at risk.

Patient Information

Name:_____

HFN:_____

DOB:_____

Date of OR:_____

Patient ASA score: □ **0** □ **1** □ **2** □ **3** □ **4**

OR Information

Procedure: _____

□ CABG x _____
SVG L R
Radial L R
LIMA RIMA
□ Valve Replacement/Repair
□ Off Pump Procedure
□ Thoracotomy
□ Endoscopic Vein Removal
□ Aorta Repair

Wound class: □ **1** □ **2** □ **3** □ **4**

Length of procedure: _____

Other intraoperative findings: _____

_____

Antibiotic Prophlyaxis:

Preop – drug and dose: _____

Timing: _____

Treatment:

Intraop – drug and dose: _____

Timing: _____

Information on Infection

Patient developed SSI? □ **YES** □ **NO**

IF YES:
Date of SSI identification:_____

Site:_____

Culture Results:

Organism: _____

Date: _____

Site: _____

Radiographic Evidence:

Date: _____

Results: _____

Signs and Symptoms of Infection:

Physician diagnosis of infection:

Treatment: _____

Date: _____

Type: _____

Notified By:

PDS Lab Floor Readmit ID

Other: _____

Figure 6: Sample cardiovascular surgical site infection chart abstraction tool

[Adapted from Sunnybrook Health Sciences Centre, Toronto, Ontario]

While the NNIS/NHSN index is the most widely-used for health care-associated infections, several investigators have shown that it was unable to accurately predict the risk of infection across a wide range of surgical procedures.[64-67] Some health care settings may find the NNIS/NHSN SSI risk index useful because it allows them to compare their rates of infection with other hospitals also using this index. However, its ability to adjust for the true risk of surgical site infection should be recognized.

Box 15 provides an example of calculating risk stratification based on wound class in a fictional hospital.

Step VII: Interpret Infection Rates

Infection Control Professionals must be able to interpret HAI rates so that they can identify areas where improvements to infection prevention and control practices are needed to lower the rate of infection, or to evaluate where preventive interventions have been effective in reducing the risk of infection. Interpreting the meaning of a rate of infection requires a close working knowledge of how one's surveillance system operates and of the changing risks of infection in one's facility. The recommended steps in interpretation of surveillance rates are summarized in Figure 7.

A hospital or long-term care home should use the following questions to guide the interpretation of a surveillance rate:

1. Are the rates accurate?

As a first step in interpretation of an infection rate, the ICP should ask: *have the rates been accurately calculated*?

a) It is recommended that all HAI rate calculations be pre-programmed into your computerized system or spreadsheet/database. Calculation of surveillance rates through a computerized system will eliminate some of the potential for the miscalculation of rates and save valuable ICP time.
b) It is also recommended that another member of the Infection Control Team review, and if necessary re-calculate, the rates using your infection data. If discrepancies in the rates are found, then identification of the area of miscalculation can serve to reinforce methods and provide additional practice in calculation of rates.

Recommended Practice 12.0: It is a recommended best practice to have a colleague review HAI rates and check their accuracy prior to any interpretation of the rate.

2. Are there any major deviations from previous data? Do the rates make sense?

At this point, the ICP will notice if a rate deviates substantially from previous surveillance periods. ICPs may substantiate this statistically through the use of a standard deviation.

Box 15: Application of Risk Stratification Methodology (acute care example)

- *The Infection Control Team at City General Hospital stratifies its rates of surgical site infections for cholecystectomy and colectomy by wound class.*
- *The team obtains information on wound class for each patient undergoing cholecystectomy and colectomy over the quarterly surveillance period from the hospital's surgical database:*

Patient ID	SSI	Wound class
Colectomy		
0001	No	II
0002	No	II
0003	Yes	III
.	.	.
.	.	.
0250	No	III
Total	**10 infected/ 250 total**	
Cholecystectomy		
0001	No	I
0002	Yes	I
0003	No	II
.		
0300	Yes	III
Total	**11 infected/300 total**	

- *The infection control team totals the number of patients in each wound class and calculates the following rates:*

Surgical Site Infections	Surgical site infections following surgery	Total number of patients undergoing surgical procedure over quarter	Rate of infection (No. infections per 100 procedures)
Colectomy	10	250	= 10 / 250 x 100 = 4.0 per 100 procedures
Wound class I-II	4	190	2.1 per 100 procedures
Wound class ≥ 3	6	60	10 per 100 procedures
Cholecystectomy	11	300	3.7 per 100 procedures
Wound class I-II	5	250	2.0 per 100 procedures
Wound class ≥ 3	6	50	12.0 per 100 procedures

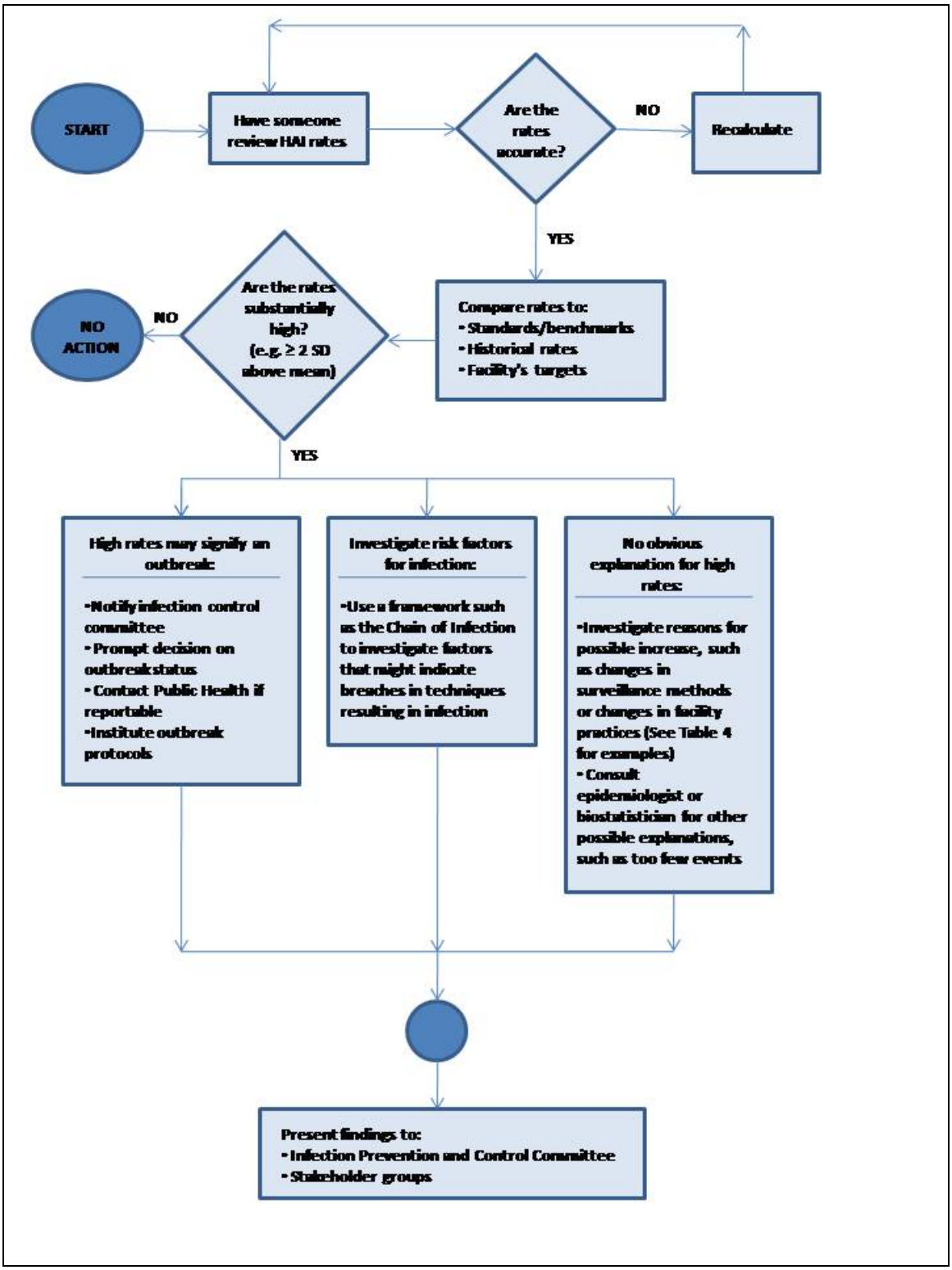


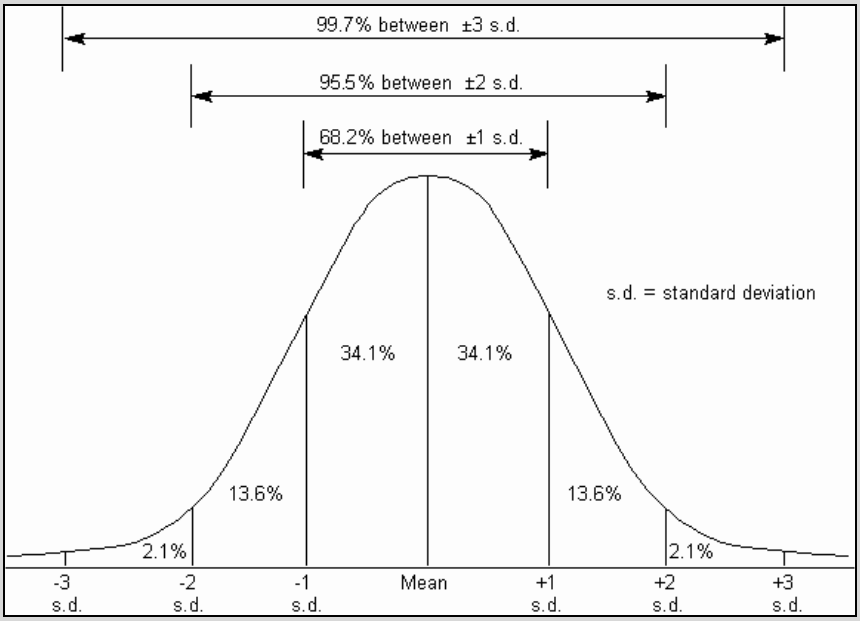
Figure 7: Recommended steps in interpretation of surveillance rates

Using standard deviation to assess data

The standard deviation of a rate of infection indicates the average variation around the mean rate, i.e. data values will lie somewhere above or below the average that has been calculated from all of the values. A rate that is farther than 2 standard deviations from the mean rate of infection represents an unusual occurrence. The Infection Control Team could seek the assistance of a biostatistician/epidemiologist in calculating the mean rate and standard deviation to assist them in interpreting whether a difference is substantial. See Box 16 for a graphical illustration of how the standard deviation may be used to guide action when HAI rates appear to be elevated.

Box 16: Use of Standard Deviation to Guide Decision-making Related to Increases in HAI Rates

- *Using standard deviation (s.d.) calculated from HAI rates, it can be seen from the graph below that 95.5% of HAI rates will fall within ± 2 s.d. of the mean rate. This can be used to determine, on a month-to-month or quarterly basis, whether a particular infection rate is acceptable or is abnormally high.*



- *For example, after generating monthly rates for MRSA colonization in Forest Manor, at the end of a year the ICP calculates a mean rate of 2 cases per 1,000 resident days.*
- *Using the rates from the previous 12 months to calculate the standard deviation results in a s.d. of 1.*
- *This means that, in any given month, 68.2% of rates will be between 1 and 3 cases per 1,000 resident days (mean ± 1 s.d.) and 95.5% of rates will be between 0 and 4 cases per 1,000 resident days (mean ± 2 s.d.).*
- *If ± 2 s.d. is considered acceptable, then only months where the rate was above 4 cases per 1,000 resident days would require investigation.*

Using critical thinking to assess data

If no errors are detected in the calculation of a rate and the rate is substantially higher or lower than expected, then the ICP should ask: *do these rates make sense*?

The ICPs' day-to-day activities in case finding provide them with a general idea of the range of frequencies of various types of infections that can be expected in their facility. The ICP can apply this working knowledge to assess whether a particular rate of infection seems reasonable, based on what they have observed in their facility over the surveillance period.

Unusually high HAI rates that signify a cluster or outbreak would normally come to the attention of the ICP before HAI rates are calculated. If an unusually high rate of infection indicates an outbreak, then the ICP should bring this to the immediate attention of the Infection Control Team and implement their outbreak management protocols if required.

Substantial deviations in HAI rate from previous surveillance periods that are not explained by an outbreak situation should be investigated by the ICP and Infection Control Team. These differences could indicate:

a) changes in hospital practices;
b) changes in surveillance methodology; or
c) changes to case definitions.

Box 17: Example of How Changes to Hospital Practices Can Affect the Apparent Infection Rate

The following demonstrates how changes in facility practices in one community hospital impacted case finding for surveillance and resulted in an apparent decrease in the rates of MRSA infection over time:

> *The Infection Control Team at this hospital was elated when the proportion of S. aureus isolates that were resistant to methicillin decreased from 34% to 0% in one surveillance month. Upon further investigation, it was found that two changes in the hospital, unrelated to the risk of MRSA, were responsible for this change. First, surgeons had begun to treat potentially infected wounds based solely on signs and symptoms. Second, the hospital laboratory began screening wound specimens and selected a limited set, meeting specific criteria, for culture. Together these changes reduced the total number of S. aureus isolates that were available for testing for methicillin resistance, including those that were positive. The observed reduction in MRSA infections were attributed to these facility changes, impacting the sensitivity of case finding, rather than to any changes in infection prevention and control practice.*
>
> *Pottinger JM, Handbook for Hospital Epidemiologists 1998*

Additional examples of changes to hospital practices and the apparent change to the rates of nosocomial infection that can result from these changes are provided Table 4.

Recommended Practice 13.0: Explore the possibility that differences in rates of infection in your facility from previous surveillance periods may be the result of institutional practices or surveillance practices.

Table 4: Examples of Practices That Affect Observed Infection Rates

(Adapted from Haley, Am J Epidemiol 1980)[68]

Change in Practice	Apparent Effect on Infection Rate
Increasing proportion of treatment taking place in outpatient setting rather than in hospital	Decrease in overall infection rate, because surveillance is rarely performed in the outpatient setting OR Increase in infection rate if low-risk procedures are performed in the outpatient setting and those taking place in hospital are among high-risk surgical patients
Length of stay in hospital following treatment is decreased	Decrease in overall rate of infection because fewer infections are detected post-discharge OR Increase in infection rate as patients staying in hospital are more severely ill and at a greater risk of infection.
Patients residing in lodging house or boarding unit of hospital are not counted as admitted patients; thus, these patients are not included in the denominator	Increased infection rate if surveillance is conducted on these units, especially if outbreaks of infections on these units (eg. C. difficile, gastroenteritis) are detected
Automated IT services office associates surgical procedure to admitting physician, regardless of physician's specialty, rather than to the surgeon performing the procedure	Inaccurate surgeon-specific infection rates, because some surgical site infections will be assigned to the wrong surgeon.
Physicians treat patients based on signs and symptoms of infection, without obtaining cultures	Decreased rate of infection if case finding relies solely on microbiology reports
Microbiology laboratory changes screening criteria for processing specimens	Decreased rate of infection if case finding methods rely on laboratory reports
Definitions inconsistently used or inconsistently applied	Inaccurate infection rates

Temporal variations impacting on data

Rates of infection may vary from previous surveillance periods due to changes related to time:

a) Seasonal variations - for example, respiratory infections have a low frequency in the summer months but may increase over the winter months;
b) Weekly variations - for example, onset of infection over the weekend may not be recognized or confirmed until Monday when patient/resident care and laboratory staffing levels increase, which may result in a higher number of infections being recorded on that day.

These contextual factors should also be considered in interpretation of a surveillance rate. If a health care setting is doing seasonal surveillance (e.g. influenza surveillance), the same time period must be used each year when doing trend comparisons.

3. Rate Comparison to Benchmarks

It is recommended that health care settings compare their HAI rates against benchmarks, both internal and external. Thee are three common rate comparisons that may be used:

a) **Recognized standards or benchmarks**. A hospital or long-term care home can evaluate their rates of infection relative to an established benchmark. For example, the U.S. NNIS/NHSN system publishes reports that present rates of HAIs compiled from 211 participating hospitals.[69, 70] HAI rates are presented with both a mean rate and percentiles, which range from 10% to 90%. ICPs may use these benchmarks if their surveillance data have been collected in the same way as the NNIS/NHSN data.

   For some infections there are recognized rate standards. For example, the mean rate of infection for clean laminectomies is 0.88%.[69] For other infections, there are no well-established benchmarks, and a group of similar health care settings may choose to benchmark against each other

b) **Rates from previous surveillance periods**. Depending on the infection of interest, health care settings should choose to compare their HAI rates to those calculated in previous surveillance periods (e.g. previous month, previous quarter, previous year) to detect changes in the risk of infection or deviations from a baseline rate, or to evaluate the effectiveness of interventions that have been implemented.

c) **Benchmarks set by one's own facility**. In a well established, ongoing surveillance system, the Infection Control Team will have a good idea of its baseline HAI rates, which may be lower than external benchmarks. In such cases, the hospital or long-term-care home may set their own goals for HAI rates based on what can be achieved in their facility and compare rates of infection to their own internal benchmarks.

In comparing HAI rates to those of other hospitals or long-term care homes, an ICP should review the surveillance methods used by these facilities. This review can assist in identifying whether differences in the rates of infection can be attributed to surveillance methods, such as different approaches to case finding, or to the use of different case definitions. Upon review of the surveillance methods of several other facilities, a health care setting should be able identify a those that use the same case definitions and similar approaches to case finding. This set of peer facilities can provide an ongoing comparison group of surveillance rates.

If the ICP suspects that there is a meaningful difference in their rate of infection relative to other facilities or to previous surveillance periods, then consultation with an epidemiologist or biostatistician can assist in determining whether any differences in the risk of infection are statistically significant. Some facilities may have this expertise available, while others may have to seek out someone with this training. The local public health unit is a good source of expertise. Another source of assistance in interpretation of surveillance rates is the Department of Epidemiology/Biostatistics of a nearby university.

Pearl of wisdom: Comparisons over time or across health care settings are only appropriate if the same case finding methods have similar sensitivities and specificities, the same case definitions are applied to establish infection and the same methods are used to calculate rates of infection and to adjust for risk factors.

Recommended Practice 14.0: Identify a set of peer institutions that use the same case definitions and similar case finding methods to serve as a comparison group. In comparing HAI rates to those of other hospitals or long-term care homes, an ICP should review the surveillance methods used by these facilities.

Effects of sample size

While HAI rates may be accurately and consistently calculated over time, they may not be meaningful if the number of events (i.e. denominator) is too small. For example, in the sample dataset shown in Box 12, there were only two reported SSIs following Laminectomy over the course of a year. A single increase in the number of laminectomy-associated SSIs (i.e. from two to three cases) would result in a 50% increase in the SSI rate (assuming the denominator, or number of procedures, remained constant).

ICPs should consider the number of events on which a rate is based when interpreting surveillance rates. A low number of events results in instability in rates of nosocomial infection. An epidemiologist/biostatistician can assist in confirming whether there are too few infection events for statistically meaningful differences to be detected.

4. Investigation of Increased HAI Rates

If the Infection Control Team determines that an increased HAI rate reflects a difference in the true rate of infection, then investigation of the cause of the increased rate is required. The '*Chain of Infection'* model provides a useful framework to guide this investigation.

This model, illustrated in Figure 8, summarizes all components necessary to the process of infection, using MRSA as an example:

a) MRSA is present in the community and hospital;
b) An elderly, immunocompromised patient with frequent hospitalizations may act as a reservoir in the hospital setting;
c) The mode of transmission is from person-to-person;
d) The hands of health care providers may serve as the vector for transmission, transferring MRSA bacteria from the colonized patient to the surgical wound of the patient's roommate;
e) The portal for entry in the roommate is the surgical site;
f) Whether or not this exposure to MRSA results in a surgical site infection depends on the individual's susceptibility to infection.

Increases in HAI rates are not necessarily a reflection of a failure in patient/resident care or of facility practice. Differences in the rate of infection arise from many factors, including:

a) Factors relating to the infectious agent, such as increased frequency of the microorganism in the hospital or community setting; and

b) Factors relating to the host, including an increasingly acutely ill and susceptible patient population in health care settings.

The Chain of Infection model may be useful in identifying areas where the infection process can be interrupted through changes to infection prevention and control practices. The model also useful when explaining changes in the epidemiology of nosocomial infections.

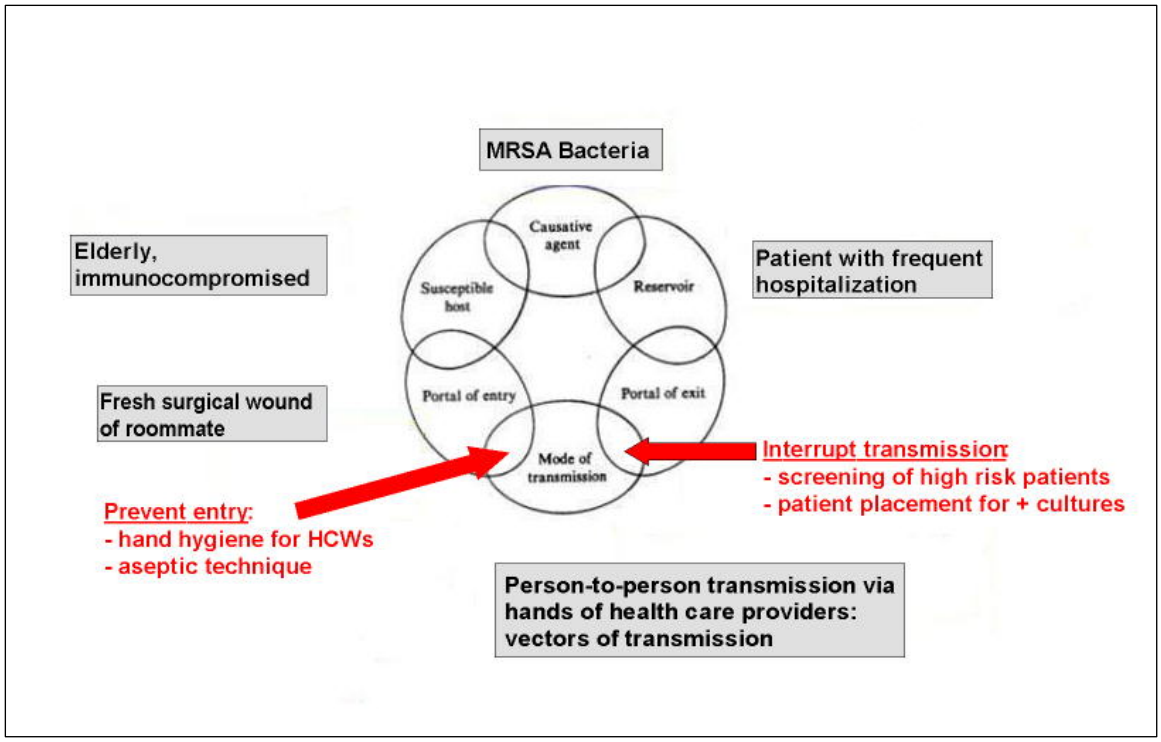


Figure 8: Chain of infection example: MRSA

Using the above example, reductions in the rate of MRSA infections may be achieved through enhanced infection prevention and control practices, such as screening patients on admission and the use of Additional Precautions for those colonized with MRSA (to interrupt transmission) or improved hand hygiene in patient care staff.

Recommended Practice 15.0: If the Infection Control Team finds that an elevated HAI rate represents an increased risk of infection, it is a recommended practice to use a conceptual framework (such as the Chain of Infection model) to suggest explanations for these rates and areas where improvements to infection control practices could reduce them.

5. Discuss Interpretation with the Infection Control Team

Once the ICP has confidence in his/her interpretation of the HAI rate, it is important to share this with others on the Infection Control Team. Where a higher rate of infection is

thought to reflect a greater risk of infection, this interpretation should form the basis for development of improved infection prevention and control practices. After an infection prevention and control program has been developed and implemented with patient/resident care staff, the eventual re-calculation of rates as part of a formal evaluation exercise would be used to assess the effectiveness this program, as demonstrated in the continuous feedback loop in Figure 1.

If the ICP is of the opinion that differences in rates of infection are due to small sample size or to changes in surveillance methods, then he/she should report this interpretation. For example:

a) An ICP might report a higher rate of SSIs over a particular surveillance period, while noting that the difference in rate was only due to one additional infection event over that period and that this rate of infection is not likely to be reflective of any changes in the risk for that particular infection.
b) An ICP in a long-term care home might report a higher rate of urinary catheter-associated UTIs relative to other facilities in the region, with an explanation that their facility uses a case definition for UTIs that includes only positive culture results, whereas the other facilities use both clinical criteria and laboratory results to establish infections.

Step VIII: Communicate and Use Surveillance Information to Improve Practice

If surveillance data are not used to effect changes to infection prevention and control practices, then the surveillance system is not working. Communication of surveillance data and their use as an input to infection prevention and control practice constitutes the end goal of an effective surveillance system. A surveillance system that simply collects and houses data without communicating it to stakeholders stops short of attaining the main goal, that of improved infection prevention and control practice and decreased rates of HAIs.

1. Communication at the Health Care Setting Level

Communication of HAI rates takes place first at the health care facility level, often to a hospital or long-term care home's infection control committee. This type of communication provides a global view of the risk of HAIs in the health care setting over a specified period of time. This communication, often in the form of a quarterly report, should outline any changes to the risk of infection across all patient/resident care areas that are covered by the surveillance system.

To assist clinicians and health care administrators to understand the interpretation of HAI rates, it is important to describe where this rate is situated relative to previous surveillance intervals or in relation to like facilities. For example, reporting a rate of 5.6 CVC-associated bloodstream infections per 1000 patient days may have little meaning to a hospital committee without knowledge as to what this rate signifies. Comparing this rate to a mean rate of infection available from a group of comparator facilities or an established benchmark rate and presenting this graphically with the facility's data are useful (refer to bar graph in Appendix H).

2. Communication Targeted to a Specific Area of Patient/resident Care

Communication of HAI rates should also be targeted to specific patient care areas or specialty services that have participated in the data collection, such as ICUs or surgical units in hospitals, or complex continuing care units in long- term care homes. These reports offer a more detailed analysis of the specific types of infections affecting patients/residents served by these particular care areas.

Information is generally presented as a written report. The targeted report may be distributed at a regular program committee meeting or could be used in a workshop, for example, which might comprise managers, health care providers and the ICP or Infection Control Team. The information provided in this report may serve as a basis for discussion between the ICPs and the program's staff on emerging concerns in patient safety, reasons for changes in their rates of infection, or the effectiveness of specific infection prevention and control practices and interventions.

The information provided in surveillance reports can also be used to direct resource allocation in infection prevention and control. This information should be directed to those able to effect change in the health care setting's practices. The dissemination of surveillance information should take place on a systematic, ongoing basis so that health care providers and administrators can anticipate the receipt of this information and use it the evaluation and planning of patient care practices.

All information provided in surveillance reports must be clear, easy to follow and provide only the information required. Information should be presented using a standardized format, as managers and/or health care providers often have little time available for an in-depth review of the data. Whenever possible, the Infection Control Team should employ visual aids, such as bar or pie charts, graphs and tables, in order to display surveillance data. Important trends, such as an increasing HAI rate, may be quickly identified when portrayed visually.

Refer to Appendix H for information regarding tools for the visual display of surveillance data.

Recommended Practice 16.0: Communication of surveillance data should take place on an ongoing, systematic basis and be targeted to those with the ability to change infection control practice. All surveillance reports should be clear and easy to follow, including the use of visual aids including pie charts, bar charts and graphs.

3. Communication of Special Alerts and Outbreaks

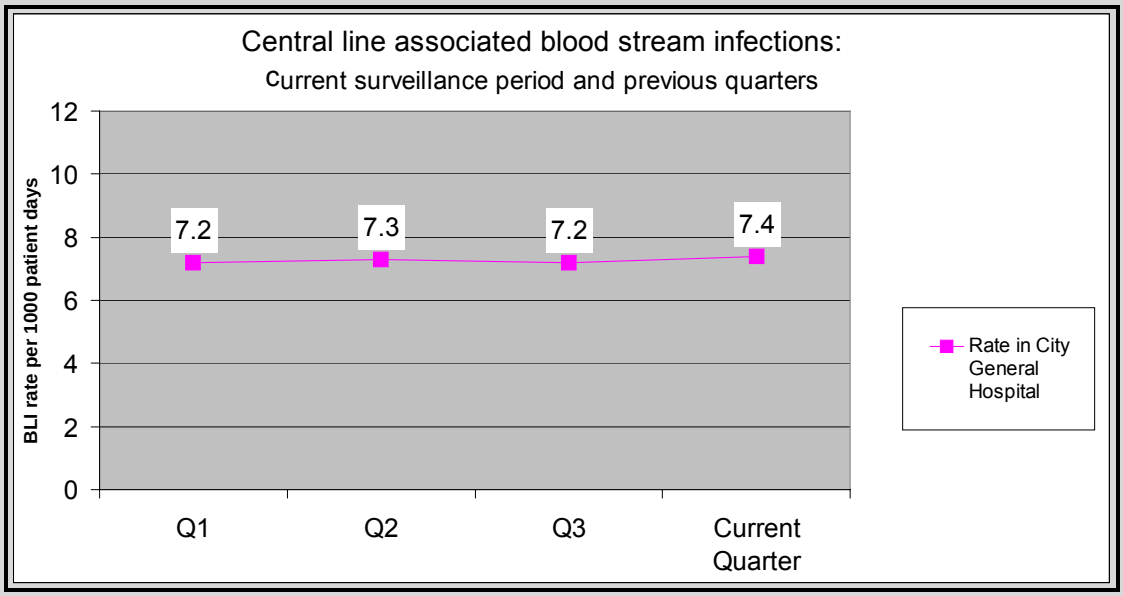
Timely communication of alerts to health care providers following identification of an emerging risk of infection is important. For example, if the Infection Control Team detects and sharp increase in the rate of infections caused by MRSA in a particular patient/resident care area of their facility, they may issue a facility-wide alert documenting the increase. The alert may also serve as an opportunity to remind patient/resident care staff of infection prevention and control practices, such as hand hygiene and routine MRSA screening practices for patients/residents admitted to that ward. Any additional infection prevention and control precautions instituted in response to this increase in HAI rate may also be outlined in this alert.

As with surveillance reports, alerts should present only key information with the use of graphs or charts whenever possible to communicate the main messages quickly and effectively.

Examples of how an Infection Control Team can undertake the dissemination of information generated through a surveillance system are provided in Boxes 18 and 19.

Box 18: Communication and Use of Surveillance Information (acute care example)

- At City General Hospital, the Infection Control Team collaborates closely with the ICU to investigate sources of nosocomial infections.
- The Infection Control Team forms a working group with the ICU manager and medical director to address the risk of nosocomial infection on an ongoing basis.
- This working group holds a quarterly workshop with the patient care staff to evaluate and review changes to patient care practices aimed at reducing the risk of infection.
- CVC-associated bloodstream infections are a major concern for the ICU working group. In preparation for this workshop, the Infection Control Team puts together a report documenting the risk of CVC-associated bloodstream infections among patients treated in the ICU over the past year.
- The graph below shows that the rate of bloodstream infections per 1000 CVC days:



The following key features help to ensure that surveillance graphs are easy to interpret:

1. The graph has a clear title and subtitle that summarize what data are being presented.
2. Both axes are labelled, with time on the x (horizontal) axis as per customary practice.
3. The denominator is clearly indicated (per 1000 central line days).
4. The timeframe of interest is clearly indicated (current and past quarterly surveillance periods).
5. There is a legend to accompany the data shown in the graph (on the right hand side in the above legend).

Unlabelled or improperly labelled axes and graphs without legends are common pitfalls impeding communication made by those presenting data that are easily rectified.

Box 18: Communication and Use of Surveillance Information (acute care example), con't.

- *The ICPs from City General Hospital dialogue with other member hospitals of the Regional Infection Control Network and the Community and Hospital Infection Control Association (CHICA) - Canada.*
- *They find that City General Hospital's rates of CVC-associated bloodstream infections are 3% higher than other similar hospitals serving similar patient populations; rates of these infections in other hospitals average 5 per 1000 line days.*
- *The ICU working group is in agreement that improvements to patient care practices have the potential to decrease the risk of bloodstream infection.*
- *They find that City General Hospital uses similar approaches in surveillance and has a similar ICU case mix to other hospitals, and that differences in these factors are not likely to explain the difference in rates.*
- *Together, the ICP and ICU undertake steps to increase compliance with guidelines for the insertion and change of CVCs. The ICPs embark on an education initiative among patient care staff to raise awareness of the guidelines for CVC insertion (e.g. that it take place under maximum barrier precautions) and for frequency of CVC changes. The ICU manager and medical director work to ensure that all necessary supplies are available for maximum barrier precautions for insertion and implement a reminder system for central line change.*
- *In the six-month period subsequent to these changes, rates of CVC-associated bloodstream infections were reduced by half. Ongoing surveillance activities and the continued presence of an ICP in the ICU serves to remind staff of these patient care practices and to examine whether this decrease in the rate of nosocomial infection is sustained over the course of subsequent surveillance periods.*

Box 19: Communication and Use of Surveillance Information (long-term care example)

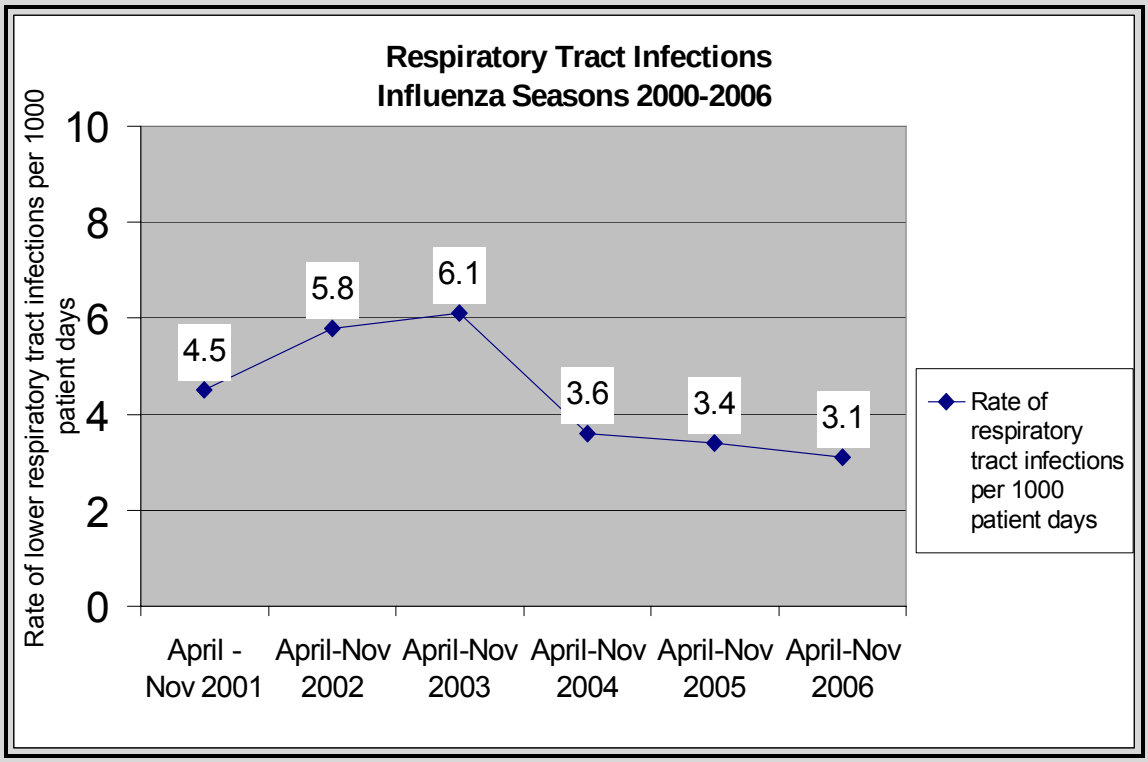
Urinary Tract Infections

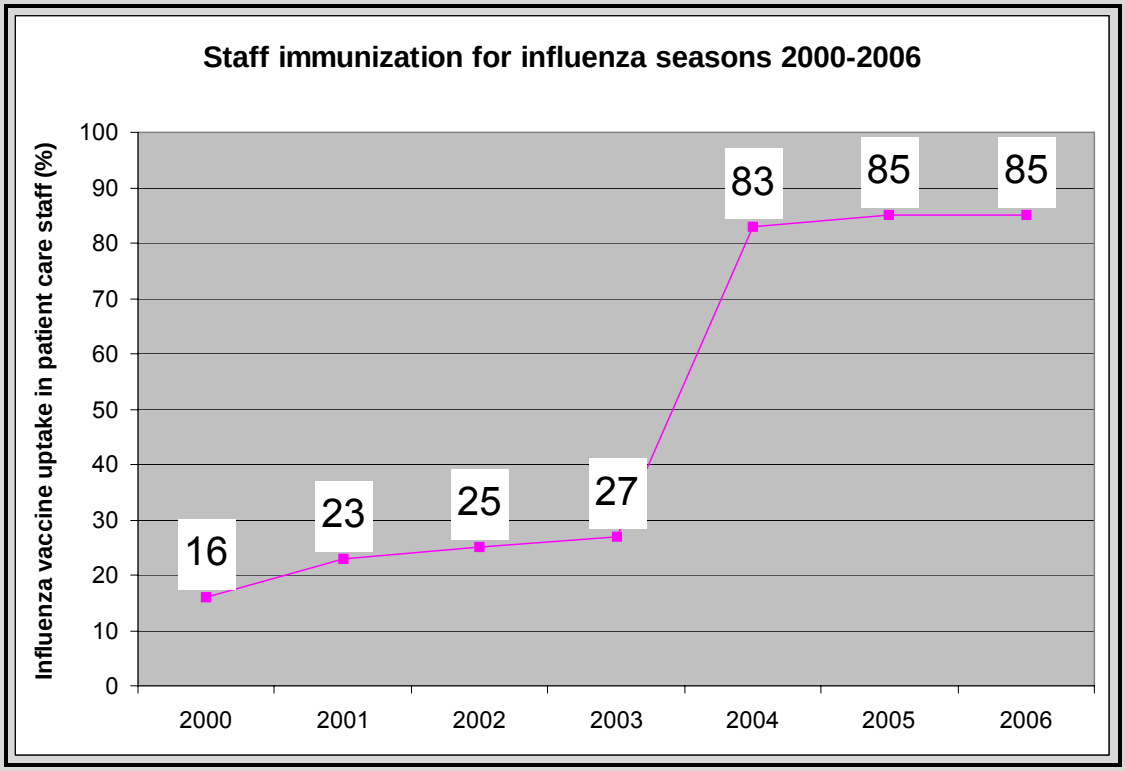
- *The ICP at Forest Manor follows potential cases of UTI as reported from the ward staff and finds an increase in the number of symptomatic UTIs associated with indwelling urinary catheters.*
- *Following collection of data on the population at risk, the ICP finds that the rate of UTIs per 1000 catheter days has not increased from previous periods. The number of resident catheter days has, however, increased from previous periods.*
- *The ICP reasons that the increased number of UTIs is due to an increase in the exposure to indwelling catheters.*
- *The ICP shares this information with nursing and administrative staff at the monthly staff meeting and initiates discussions on potential reasons for the increase in indwelling urinary catheter use and on ways that the use of these devices can possibly be decreased.*

Acute Respiratory Infections

- *The ICP at Forest Manor also compiles data on the rates of lower respiratory tract infections in residents over the past five previous influenza seasons.*
- *The ICP presents this data alongside the proportion of patient care staff receiving annual influenza vaccination, as documented in employee records, in the graphs below.*
- *The graphs demonstrate a substantial decline in the rates of respiratory tract infection over the last two influenza seasons at Forest Manor, coinciding with the highest rates of vaccine uptake among health care providers.*
- *At Forest Manor, the proportion of immunized health care providers increased modestly from 2001 to 2003 following an active education campaign to increase compliance with vaccine recommendations.*
- *It was only in 2005, when vaccination coverage was at its highest, that the most substantial impact on lowering the rates of lower respiratory tract infections was achieved.*
- *This data clearly demonstrated the impact that health care provider immunization had on respiratory tract infections in residents, and was used to form the institutional policies necessary to achieve vaccine coverage in staff.*

Box 19: Communication and Use of Surveillance Information (long-term care example), con't.





Step IX: Evaluate the Surveillance System

A final recommended practice is evaluation of the surveillance system, which entails a review of:

a) how efficiently and effectively the surveillance system works (process evaluation); and
b) how the information produced by a surveillance system is used to reduce the risk of health care-associated infection (outcome evaluation).

1. Process Evaluation

A surveillance system should have built-in procedures for the evaluation of how the system is working on a day-to-day basis. Periodic review of surveillance methods should be incorporated as part of regular Infection Control Committee meetings. These review sessions will provide an opportunity for the Infection Control Team to challenge case definitions, case finding methods (including number of potential cases missed) and other surveillance procedures. The participation of internal/external peers, such as infection control professionals from other health care settings, at these sessions can provide a helpful perspective and new ideas and suggestions as to how a facility's surveillance system may be improved.

An example of a peer review session to evaluate surveillance definitions may be found in Box 20.

Box 20: Surveillance Process Evaluation (acute care example)

- *The Infection Control Team at City General Hospital invites ICPs from nearby member hospitals within the Regional Infection Control Networks and an epidemiologist from the local public health unit to join them in an exercise that will assess the consistency of application of case definitions for infection.*
- *A series of charts from patients with suspected or confirmed health care-associated infections are selected at random and all participants at the review apply case definitions, deciding whether a particular case meets the definition for infection based on all available chart information.*
- *The group discusses and challenges each others' application of case definitions and comes to consensus on certain issues.*
- *This exercise assists in assuring consistency in application of case definitions both within City General Hospital and in other institutions in the region.*

2. Outcome Evaluation

The Infection Control Team may use the following questions to evaluate how the surveillance system is impacting infection prevention and control and how the information produced from surveillance is used to reduce HAIs in their health care setting:

a) Did the surveillance system detect clusters or outbreaks?
b) Which patient/resident care practices were changed based on surveillance data?
c) Were the data used to assess the efficacy of interventions?
d) Were the data used to make procedural changes to decrease the endemic rate of infection?

e) Is surveillance of this infection still of value (if the number of cases or rate of infection is exceptionally low, then surveillance for the infection may not be warranted)?

Where surveillance data are not used as effectively as they could be to effect changes to practice, the Infection Control Team should examine the underlying reasons for this and if necessary make changes to its surveillance system.

3. Ongoing Surveillance System Improvement

It should be expected that a surveillance system will undergo continual modification or re-alignment to ensure that it is working towards improved infection prevention and control, as demonstrated in Figure 1 by the continuous feedback loop of the surveillance system components. Modifications to a surveillance system might include:

a) re-assessment of the infections monitored;
b) changes to the approach to case finding; and
c) ways in which information generated by the system is communicated to other health care providers and decision-makers.

Recommended Practice 17.0: Hospitals and long-term care homes should regularly review the surveillance process implemented in their facility (e.g. application of case definitions, case finding and communication methods) and make modifications as needed.

At least once annually, hospitals and long-term care homes should review the outcomes of their surveillance systems (i.e. reductions to the risk of infection) and re-align system objectives as required.

Summary of Best Practices

The best practices recommended in this document are summarized below:

	Recommendation	Compliant	Partial Compliance	Non-compliant	Action Plan	Accountability
BEST PRACTICES FOR SURVEILLANCE OF HEALTH CARE-ASSOCIATED INFECTIONS						
1.0	As a first step in the planning of a surveillance system, it is a recommended practice that a health care setting assess: • the types of patients/residents that it serves • the key medical interventions and procedures that they undergo • the types of infections for which they are most at risk This assessment is done to establish priorities for the surveillance system.					
2.0	Syndromic surveillance of respiratory infections and gastroenteritis should be undertaken in all hospitals and long- term care homes. Where hospitals and long-term care homes select outcomes for surveillance in addition to the infections listed above, the following should be considered: • the frequency of the infection • the impacts of the infection (including percent case fatality and excess costs associated with the infection) • the preventability of the infection In both hospitals and long-term care, the outcomes selected for					

	Recommendation	Compliant	Partial Compliance	Non-compliant	Action Plan	Accountability
	surveillance should be re-evaluated at least annually.					
3.0	Hospitals should use the NNIS/NHSN case definitions for nosocomial infections provided in Appendix B. Long-term care homes should use the Canadian Consensus Conference definitions for health care-associated infections in long-term care provided in Appendix C.					
4.0	Hospitals and long-term care homes should take steps to ensure that case definitions are consistently and accurately applied.					
5.0	Active surveillance is a recommended best practice for surveillance programs in hospitals and long-term care homes because of the higher sensitivity associated with this approach to case finding.					
6.0	It is a recommended practice to adjust rates of health care-associated infection for patient/resident length of stay by using the number of patient/resident days as the denominator, rather than number of admissions or number of beds.					
7.0	It is a recommended best practice to calculate of rates of surgical site infection in patients undergoing the same surgical procedure. Strategies should also be developed to detect surgical site infections post-discharge. There is no generally accepted method for conducting post-discharge surveillance outside the hospital setting.					
8.0	It is a recommended best practice to calculate rates of device-associated infection that are adjusted for duration of exposure to the device.					

	Recommendation	Compliant	Partial Compliance	Non-compliant	Action Plan	Accountability
9.0	When collecting data for the denominator for device-associated infection rates, it is a recommended best practice to collect data on the length of time that each patient/resident was exposed to a particular device, rather than the total number of days that all patients were exposed to the device.					
10.0	Health care settings should use electronic systems to store data and assist with the calculation of HAI rates.					
11.0	It is a recommended best practice that hospitals stratify rates of procedure-specific surgical site infections by wound class.					
12.0	It is a recommended best practice to have a colleague review HAI rates and check their accuracy prior to any interpretation of the rate.					
13.0	Explore the possibility that differences in rates of infection in your facility from previous surveillance periods may be the result of institutional practices or surveillance practices.					
14.0	Identify a set of peer institutions that use the same case definitions and similar case finding methods to serve as a comparison group. In comparing HAI rates to those of other hospitals or long-term care homes, an ICP should review the surveillance methods used by these facilities.					
15.0	If the Infection Control Team finds that an elevated HAI rate represents an increased risk of infection, it is a recommended practice to use a conceptual framework (such as the Chain of Infection model) to suggest explanations for these rates and areas where improvements to infection control practices could reduce					

	Recommendation	Compliant	Partial Compliance	Non-compliant	Action Plan	Accountability
	them.					
16.0	Communication of surveillance data should take place on an ongoing, systematic basis and be targeted to those with the ability to change infection control practice. All surveillance reports should be clear and easy to follow, including the use of visual aids including pie charts, bar charts and graphs.					
17.0	Hospitals and long-term care homes should regularly review the surveillance process implemented in their facility (e.g. application of case definitions, case finding and communication methods) and make modifications as needed. At least once annually, hospitals and long-term care homes should review the outcomes of their surveillance systems (i.e. reductions to the risk of infection) and re-align system objectives as required.					

Appendices

Appendix A: Evidence for the Effectiveness of Surveillance Systems in Reducing Health Care-Associated Infections

A search strategy was developed and executed in MEDLINE (1950-2007) to identify all English language studies that investigated whether the establishment of a surveillance system was associated with a decrease in the rate of health care-associated infections (HAIs). Combinations of the search terms indicated below initially yielded 317 studies. Subsequent review of the abstracts from the electronic records and of reference lists identified 11 studies that examined a change in the rate of HAIs following establishment of a surveillance system in a hospital or long-term care home.

Search Terms Used to Identify Studies for Subsequent Review

Nosocomial infection.mp. or cross infection
Long-term care
Health-care acquired
Sentinel surveillance/ or population surveillance
Surgical wound Infection/ or surgical site infection.mp. / or surveillance.mp
Urinary tract infections
Pneumonia/ or ventilator-associated
Drug resistance, Multiple/ or Drug Resistance, Microbial
Catheterization, central venous
Evaluation studies
Effectiveness
Cost benefit analysis
Benchmarking
Practice guidelines/ or best practices

The studies that were identified were then assessed with respect to two main evaluative criteria:

1. Adjustment for case mix factors. Studies were assessed by whether they controlled for potential differences in the risk of HAIs that could have explained any changes in HAI rates prior to, and following, the establishment of surveillance systems.

2. Identifiable impact of the surveillance system. An examination of the mechanisms through which reductions in HAI rates are likely to have resulted are important to the assessment of the contribution of the surveillance system (and/or the changes it brings about) to reduced rates of HAI.

Eleven studies were identified that examined the impact of surveillance on risk of HAI. The design, populations examined, results and evaluation of each of the 11 studies are summarized in the table below.

Although none of the studies completely met the evaluative criteria, overall this review shows a clear association between development of a system of surveillance and reduction in the risk of HAIs in hospitals. Although none of the studies examined the impact of surveillance systems in long-term care, there is no reason to suggest that similar effects would not be observed in that setting.

Summary of Studies Associating Change in Risk of Nosocomial Infection with Establishment of a Surveillance System

Study	Summary study design	Key results	Adjustment for case mix factors	Identifiable Impact of surveillance
Haley et al.[23]	Compared rates of surgical site infections, urinary tract infections, pneumonias and bacteremias in a nationally representative set of U.S. hospitals prior to, and following, the establishment of surveillance systems.	Hospitals that established strong systems of infection and control and surveillance experienced reduction in rates of nosocomial infections ranging from 7-50%, depending on the type of infection.	Analysis controlled for several patient and procedure-related risk factors for nosocomial infections.	Study identified specific surveillance system components associated with a decline in the rates of nosocomial infection.
Gastmeier et al.[24]	Examined the reduction in the rates of ventilator-associated pneumonias, central venous catheter-related bloodstream infections and surgical site infections in hospitals following implementation of the German National Nosocomial Infection Surveillance system.	Following implementation of surveillance system, an approximate 30% decrease in the rate of pneumonias and surgical site infections and 20% reduction in bloodstream infections was observed.	Data on other risk factors for infection was only available for surgical site infections.	While the authors note no overall changes in national hospital care practices during the study period, investigators could not take into account infection control practices in individual participating hospitals.
Mintjes-de Groot et al.[25]	Single institution study in the Netherlands that examined rates of urinary tract infections, surgical site infections, lower respiratory tract infections and bacteremias over a 13-year period.	Forty percent reduction in overall rate of surgical site infections over the study period.	No adjustment for case mix factors that could have influenced rates of infection over time.	The authors' explain that the identification of two high risk areas (general surgery and orthopaedics) through the surveillance system, with subsequent targeting in infection control, drove the decline in rates of infection.

Study	Summary study design	Key results	Adjustment for case mix factors	Identifiable Impact of surveillance
Gastmeier et al.[26]	Examined the effect of infection control working groups and systems of surveillance on the occurrence of nosocomial infections (surgical site infections, urinary tract infections, lower respiratory tract infections, bloodstream infections) in German hospitals. The frequency of infection was compared to a group of hospitals in which no intervention took place.	The establishment of surveillance systems in intervention hospitals, after infection control working groups were operational, did not result in an additional reduction in nosocomial infection.	Analysis was unadjusted for any risk factors for several case mix factors	The continued presence of the study staff in both intervention and control hospitals may have produced a "surveillance effect", making additional impacts of surveillance difficult to detect.
Olson and Lee[27]	Single institution study examining changes in surgical site infections over a 10-year period.	Rates of surgical site infection declined significantly from the index year, from 4.2% of operative procedures to approximately 2%, sustained over the study period.	Rates were adjusted for wound class only.	No changes in infection control practices coincided with implementation of the surveillance program.
Brandt et al.[28]	Examined changes in the rates of surgical site infections in the period following surveillance among hospitals participating in the German national surveillance program.	Surgical site infections were reduced by 25% following implementation of the surveillance program.	Analysis adjusted for several patient and procedural-related risk factors.	No changes to infection control practices are discussed.
Geubbels et al.[29]	Examined changes in the rates of surgical site infections in the period following surveillance among hospitals participating in the Dutch national surveillance	Surgical site infections were reduced by approximately 60% for five years following implementation of the surveillance program.	Analysis adjusted for several patient and procedural-related risk factors.	Infection control measures informed by the information generated by the surveillance programs are thought to be an underlying factor in the

Study	Summary study design	Key results	Adjustment for case mix factors	Identifiable Impact of surveillance
	program.			continued decline in rate of infection.
Sykes et al.[30]	Examined changes in the rate of surgical site infection following interruption of a surveillance program in a single hospital.	Rates of nosocomial infection increased to pre-surveillance levels following interruption of the surveillance program.	Rates were not adjusted by any patient risk factors.	No changes to infection control practices over the period of interruption were mentioned.
Barwolff et al.[31]	Examined changes in the rates of surgical site infections associated with Caesarean delivery associated with participation in the German national nosocomial surveillance program.	An approximate 40% reduction in surgical site infections was observed following implementation of the program.	Analysis adjusted for several patient and procedural-related risk actors.	Increased awareness of infection control practices, resulting from the surveillance program, was thought to be responsible for the decline in rates of surgical site infections.
Cruse and Foord[32]	Examined changes in the rates of surgical site infections following implementation of surveillance in two hospitals in Calgary.	Rates declined from 5.8% to 2.5% and from 5.7% to 3.3% of all surgical procedures in each hospital respectively, in the six months following implementation of the surveillance program and reporting of rates.	Analysis was unadjusted for any risk factors for surgical site infection.	Continued decline in rates of surgical site infections were observed following implementation of infection control practices informed by surveillance system.
Merle et al.[33]	Single facility study examining change in urinary tract infections (UTI) associated with surveillance in France.	The proportion of patients developing a UTI was reduced from approximately 14% to 12% of catheterized patients.	Analysis was unadjusted for any risk factors for UTI.	No specific changes to infection control practices were explained.

Appendix B: Recommended Case Definitions for Surveillance of Health Care-Associated Infections in Hospitals

[Source: U.S. Centers for Disease Control and Prevention, National Nosocomial Infection Surveillance Program/National Healthcare Safety Network (NNIS/NHSN)[45]]

A. Primary Bloodstream Infection

Primary bloodstream infections are classified according to the criteria used, either as laboratory-confirmed bloodstream infection (LCBI) or clinical sepsis (CSEP).

CSEP may be used to report only a primary BSI in neonates (< 30 days old) and infants (< 1 year old)

Laboratory-confirmed bloodstream infection (LCBI)

LCBI criteria may be used for all patients.

LCBI must meet *one* of the following three criteria:

Criterion 1: Patient has a recognized pathogen cultured from one or more blood cultures

and

organism cultured from blood is not related to an infection at another site

Criterion 2: Patient has at least one of the following signs or symptoms: fever (>38°C), chills, or hypotension

and

signs and symptoms and positive laboratory results are not related to an infection at another site

and

at least *one* of the following:

a) common skin contaminant (e.g., diphtheroids, *Bacillus* sp. *Propionibacterium* sp., coagulase-negative staphylococci, or micrococci) is cultured from two or more blood cultures drawn on separate occasions

b) common skin contaminant (e.g., diphtheroids, *Bacillus* sp., *Propionibacterium* sp., coagulase-negative staphylococci, or micrococci) is cultured from at least one blood culture from a patient with an intravascular line, and the physician institutes appropriate antimicrobial therapy

c) positive antigen test on blood (e.g., *H. influenzae*, *S. pneumoniae*, *N. meningitidis*, or Group B *Streptococcus*)

Criterion 3: Patient < 1 year of age has at least one of the following signs or symptoms fever (>38°C, rectal), hypothermia (<37°C, rectal), apnea, or bradycardia

and

signs and symptoms and positive laboratory results are not related to an infection at another site

and

at least *one* of the following:

a) common skin contaminant (e.g., diphtheroids, *Bacillus* sp., *Propionibacterium* sp., coagulase-negative staphylococci, or micrococci) is cultured from two or more blood culturesdrawn on separate occasions

b) common skin contaminant (e.g., diphtheroids, *Bacillus* sp., *Propionibacterium* sp., coagulase-negative staphylococci, or micrococci) is cultured from at least one blood culture from a patient with an intravascular line, and physician institutes appropriate antimicrobial therapy

Clinical sepsis (CSEP)

CSEP may be used only to report a primary BSI in neonates and infants.

Criterion: Patient < 1 year of age has at least *one* of the following clinical signs or symptoms with no other recognized cause: fever (>38°C, rectal), hypothermia (<37°C), rectal), apnea, or bradycardia

and

blood culture not done or no organisms or antigen detected in blood

and

no apparent infection at another site

and

physician institutes treatment for sepsis

B. Pneumonia

Pneumonia (PNEU) is identified by using a combination of radiologic, clinical and laboratory criteria. Physician's diagnosis alone is not an acceptable criterion for nosocomial pneumonia.

Algorithms have been developed for three types of pneumonias:

I. Site-Specific Algorithms for Clinically Defined Pneumonia (PNU1)

Radiology	**Signs/Symptoms/Laboratory**
Two or more serial chest radiographs with at least **one** of the following[1,2]: New or progressive and persistent infiltrate Consolidation Cavitation Pneumatoceles, in infants ≤ 1 year old	FOR ANY PATIENT, at least **one** of the following: -Fever (>38°C or >100.4°F) with no other recognized cause -Leukopenia (<4000 WBC/mm^3) or leukocytosis (≥12,000 WBC/mm^3) -For adults ≥70 years old, altered mental status with no other recognized cause **and** at least **two** of the following: -New onset of purulent sputum[3], or change in character of sputum[4], or increased respiratory secretions, or increased suctioning requirements -New onset or worsening cough, or dyspnea, or tachypnea[5] -Rales[6] or bronchial breath sounds -Worsening gas exchange (e.g. O_2 desaturations (e.g., $PaO_2/FiO_2 \leq 240$)[7], increased oxygen requirements, or increased ventilator demand)
NOTE: In patients **without** underlying pulmonary or cardiac disease (e.g. respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest radiograph is acceptable.[1]	ALTERNATE CRITERIA, for infants ≤1 year old: Worsening gas exchange (e.g., O_2 desaturations, increased oxygen requirements, or increased ventilator demand) **and** at least **three** of the following: -Temperature instability with no other recognized cause -Leukopenia (<4000 WBC/mm^3) or leukocytosis (≥15,000 WBC/mm^3) and left shift (≥10% band forms) -New onset of purulent sputum[3] or change in character of sputum[4], or increased respiratory secretions or increased suctioning requirements -Apnea, tachypnea[5], nasal flaring with retraction of chest wall or grunting -Wheezing, rales[6], or rhonchi -Cough -Bradycardia (<100 beats/min) or tachycardia (>170 beats/min)
	ALTERNATE CRITERIA, for child >1 year old, at least **three** of the following: -Fever (>38.4°C or >101.1°F) or hypothermia (<37°C or <97.7°F) with no other recognized cause -Leukopenia (<4000 WBC/mm^3) or leukocytosis (≥15,000 WBC/mm^3) -New onset of purulent sputum[3], or change in character of sputum[4], or increased respiratory secretions, or increased suctioning requirements -New onset or worsening cough, or dyspnea, apnea, or tachypnea[5]. -Rales[6] or bronchial breath sounds. -Worsening gas exchange (e.g. O_2 desaturations, increased oxygen requirements, or increased ventilator demand)

II. Specific Site Algorithms for Pneumonia with Common Bacterial or Filamentous Fungal Pathogens and Specific Laboratory Findings (PNU2)

Radiology	**Signs/Symptoms**	**Laboratory**
Two or more serial chest radiographs with at least one of the following[1,2]: New or progressive and persistent infiltrate Consolidation Cavitation Pneumatoceles, in infants ≤ 1 year old NOTE: In patients **without** underlying pulmonary or cardiac disease (e.g. respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest radiograph is acceptable.[1]	At least **one** of the following: Fever (>38°C or >100.4°F) with no other recognized cause Leukopenia (<4000 WBC/mm^3) or leukocytosis (≥12,000 WBC/mm^3) For adults ≥70 years old, altered mental status with no other recognized cause **and** at least **one** of the following: New onset of purulent sputum[3], or change in character of sputum[4], or increased respiratory secretions, or increased suctioning requirements New onset or worsening cough, or dyspnea or tachypnea[5] Rales[6] or bronchial breath sounds Worsening gas exchange (e.g. O_2 desaturations [e.g., $PaO_2/FiO_2 \leq 240$][7], increased oxygen requirements, or increased ventilator demand)	At least **one** of the following: Positive growth in blood culture[8] not related to another source of infection Positive growth in culture of pleural fluid Positive quantitative culture[9] from minimally contaminated LRT specimen (e.g., BAL or protected specimen brushing) ≥5% BAL-obtained cells contain intracellular bacteria on direct microscopic exam (e.g., Gram stain) Histopathologic exam shows at least **one** of the following evidences of pneumonia: Abscess formation or foci of consolidation with intense PMN accumulation in bronchioles and alveoli Positive quantitative culture[9] of lung parenchyma Evidence of lung parenchyma invasion by fungal hyphae or pseudohyphae

III. Specific Site Algorithms for Pneumonias with Viral, *Legionella, Chlamydia, Mycoplasma* and other Uncommon Pathogens and Specific Laboratory Findings (PNU2)

Radiology	**Signs/Symptoms**	**Laboratory**
Two or more serial chest radiographs with at least one of the following[1,2]: New or progressive and persistent infiltrate Consolidation Cavitation Pneumatoceles, in infants ≤ 1 year old NOTE: In patients **without** underlying pulmonary or cardiac disease (e.g. respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest radiograph is acceptable.[1]	At least one of the following: Fever (>38°C or >100.4°F) with no other recognized cause Leukopenia (<4000 WBC/mm^3) or leukocytosis (≥12,000 WBC/mm^3) For adults ≥70 years old, altered mental status with no other recognized cause and at least one of the following: New onset of purulent sputum[3], or change in character of sputum[4], or increased respiratory secretions, or increased suctioning requirements New onset or worsening cough or dyspnea, or tachypnea[5] Rales[6] or bronchial breath sounds Worsening gas exchange (e.g. O_2 desaturations [e.g., $PaO_2/FiO_2 \leq 240$][7], increased oxygen requirements, or increased ventilator demand)	At least one of the following[10-12]: Positive culture of virus or *Chlamydia* from respiratory secretions Positive detection of viral antigen or antibody from respiratory secretions (e.g., EIA, FAMA, shell vial assay, PCR) Fourfold rise in paired sera (IgG) for pathogen (e,g., influenza viruses, *Chlamydia*) Positive PCR for *Chlamydia* or *Mycoplasma* Positive micro-IF test for *Chlamydia* Positive culture or visualization by micro-IF of *Legionella* spp, from respiratory secretions or tissue. Detection of *Legionella pneumophila* serogroup 1 antigens in urine by RIA or EIA Fourfold rise in *L. pneumo*phila serogroup 1 antibody titer to ≥1:128 in paired acute and convalescent sera by indirect IFA.

IV. Specific Site Algorithm for Pneumonia in Immunocompromised Patients (PNU3)

Radiology	Signs/Symptoms	Laboratory
Two or more serial chest radiographs with at least one of the following[1,2]: New or progressive and persistent infiltrate Consolidation Cavitation Pneumatoceles, in infants ≤ 1 year old NOTE: In patients **without** underlying pulmonary or cardiac disease (e.g. respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), one definitive chest radiograph is acceptable.[1]	Patient who is immunocompromised[13] has at least one of the following: Fever (>38°C or >100.4°F) with no other recognized cause For adults ≥70 years old, altered mental status with no other recognized cause New onset of purulent sputum[3], or change in character of sputum[4], or increased respiratory secretions, or increased suctioning requirements New onset or worsening cough, or dyspnea, or tachypnea[5] Rales[6] or bronchial breath sounds Worsening gas exchange (e.g. O_2 desaturations [e.g., $PaO_2/FiO_2 \leq 240$], increased oxygen requirements, or increased ventilator demand) Hemoptysis Pleuritic chest pain	At least one of the following: Matching positive blood and sputum cultures with *Candida* spp. [14, 15] Evidence of fungi or *Pneumocystis carinii* from minimally contaminated LRT specimen (e.g., BAL or protected specimen brushing) from one of the following: - Direct microscopic exam - Positive culture of fungi Any of the following from **LABORATORY CRITERIA DEFINED UNDER PNU2**

C. Urinary Tract Infections

Catheter-associated urinary tract infections are classified into two groups with specific sets of criteria for each: symptomatic urinary tract infections (SUTI) and asymptomatic bacteriuria (ASB).

Symptomatic urinary tract infection (SUTI)

A symptomatic urinary tract infection must meet at least *one* of the following criteria:

Criterion 1: Patient has at least *one* of the following signs or symptoms with no other recognized cause: fever (>38°C), urgency, frequency, dysuria, or suprapubic tenderness

and

patient has a positive urine culture, that is, $\geq 10^5$ microorganisms per mL of urine with no more than two species of microorganisms

Criterion 2: Patient has at least *two* of the following signs or symptoms with no other recognized cause: fever (>38°C), urgency, frequency, dysuria, or suprapubic tenderness

and

at least *one* of the following:

a) positive dipstick for leukocyte esterase and/or nitrate
b) pyuria (urine specimen with ≥10 wbc/mL or ≥3 wbc/high power field of unspun urine)
c) organisms seen on Gram stain of unspun urine
d) at least two urine cultures with repeated isolation of the same uropathogen (Gram-negative bacteria or *S. saprophyticus*) with $\geq 10^2$ colonies/mL in nonvoided specimens
e) $\leq 10^5$ colonies/mL of a single uropathogen (gram-negative bacteria or *S.saprophyticus*) in a patient being treated with an effective antimicrobial agent for a urinary tract infection
f) physician diagnosis of a urinary tract infection
g) physician institutes appropriate therapy for a urinary tract infection

Criterion 3: Patient < 1 year of age has at least one of the following signs or symptoms with no other recognized cause: fever (>38°C rectal), hypothermia (<37°C rectal), apnea, bradycardia, dysuria, lethargy, or vomiting

and

patient has a positive urine culture, that is, $\geq 10^5$ microorganisms per mL of urine with no more than two species of microorganisms

Criterion 4: Patient < 1 year of age has at least one of the following signs or symptoms with no other recognized cause: fever (>38°C rectal), hypothermia (<37°C rectal), apnea, bradycardia, dysuria, lethargy, or vomiting

and

at least *one* of the following:
a) positive dipstick for leukocyte esterase and/or nitrate
b) pyuria (urine specimen with ≥10 wbc/mL or ≥3 wbc/high power field of unspun urine)
c) organisms seen on Gram stain of unspun urine
d) at least two urine cultures with repeated isolation of the same uropathogen (Gram-negative bacteria or *S. saprophyticus*) with $\geq 10^2$ colonies/mL in nonvoided specimens
e) $\leq 10^5$ colonies/mL of a single uropathogen (gram-negative bacteria or *S. saprophyticus*) in a patient being treated with an effective antimicrobial agent for a urinary tract infection
f) physician diagnosis of a urinary tract infection
g) physician institutes appropriate therapy for a urinary tract infection

Asymptomatic Bacteriuria (ASB)

An asymptomatic bacteriuria must meet at least *one* of the following criteria:

Criterion 1: Patient has had an indwelling urinary catheter within 7 days before the culture

and

patient has a positive urine culture, that is, ≥10^5 microorganisms per mL of urine with no more than two species of microorganisms

and

patient has no fever (>38°C), urgency, frequency, dysuria, or suprapubic tenderness

D. Surgical Site Infections

Surgical site infections are categorized into three groups:

I. Superficial Incisional SSI

Criterion: Infection occurs within 30 days after the operative procedure

and

involves only skin and subcutaneous tissue of the incision

and

patient has at least *one* of the following:

a) purulent drainage from the superficial incision
b) organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision
c) at least *one* of the following signs or symptoms of infection:
   i. pain or tenderness, localized swelling, redness, or heat, *and*
   ii. superficial incision is deliberately opened by surgeon, *and* is culture-positive or not cultured. A culture-negative finding does not meet this criterion
d) diagnosis of superficial incisional SSI by the surgeon or attending physician

Reporting Instructions:

- Do *not* report a stitch abscess (minimal inflammation and discharge confined to the points of suture penetration) as an infection.
- Do not report a localized stab wound infection as SSI, instead report as skin or soft tissue infection, depending on its depth.
- Report infection of the circumcision site in newborns as SSTCIRC. Circumcision is not an NNIS/NHSN operative procedure.
- Report infection of the episiotomy site as REPR-EPIS. Episiotomy is not an NNIS/NHSN operative procedure.
- Report infected burn wound as SST-BURN.
- If the incisional site infection involves or extends into the fascial and muscle layers, report as a deep incisional SSI.
- Classify infection that involves *both* superficial and deep incision sites as deep incisional SSI.

II. Deep Incisional SSI

Criterion: Infection occurs within 30 days after the operative procedure if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operative procedure

and

involves deep soft tissues (e.g., fascial and muscle layers) of the incision

and

patient has at least *one* of the following:

a) Purulent drainage from the deep incision but not from the organ/space component of the surgical site
b) A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least *one* of the following signs or symptoms:
   i. fever (> 38°C), or
   ii. localized pain or tenderness, *unless* incision is culture-negative
c) An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation or by histopathologic or radiologic examination
d) Diagnosis of a deep incisional SSI by a surgeon or attending physician

Reporting Instructions:

- Classify infection that involves *both* superficial and deep incision sites as deep incisional SSI.

III Organ/Space SSI

An organ/space SSI involves any part of the body, excluding the skin incision, fascia, or muscle layers, that is opened or manipulated during the operative procedure. Specific sites are assigned to organ/space SSI to further identify the location of the infection. The table below lists the specific sites that must be used to differentiate organ/space SSI. An example is appendectomy with subsequent subdiaphragmatic abscess, which would be reported as an organ/space SSI at the intraabdominal specific site (SSI-IAB).

Criterion: Infection occurs within 30 days after the operative procedure if no implant is left in place or within one year if implant is in place and the infection appears to be related to the operative procedure

and

infection involves any part of the body, excluding the skin incision, fascia, or muscle layers, that is opened or manipulated during the operative procedure

and

patient has at least *one* of the following:

a) purulent drainage from a drain that is placed through a stab wound into the organ/space
b) organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space

c) an abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathologic or radiologic examination
d) diagnosis of an organ/space SSI by a surgeon or attending physician

Reporting Instructions:

- Occasionally, an organ/space infection drains through the incision. Such infection generally does not involve re-operation and is considered a complication of the incision. Therefore, it is classified as a deep incisional SSI
- Report culture specimen from organ/space as DD (deep drainage)

Specific Sites of an Organ/Space SSI

CODE	SITE	CODE	SITE
BONE	**Osteomyelitits**	**LUNG**	**Other infections of the respiratory tract**
BRST	**Breast abscess or mastitis**	**MED**	**Mediastinitis**
CARD	**Myocarditis or pericarditis**	**MEN**	**Meningitis or ventriculitis**
DISC	**Disc space**	**ORAL**	**Oral cavity (mouth, tongue, or gums)**
EAR	**Ear, mastoid**	**OREP**	**Other infections of the male or female reproductive tract**
EMET	**Endometritis**	**OUTI**	**Other infections of the urinary tract**
ENDO	**Endocarditis**	**SA**	**Spinal abscess without meningitis**
EYE	**Eye, other than conjunctivitis**	**SINU**	**Sinusitis**
GIT	**GI tract**	**UR**	**Upper respiratory tract**
IAB	**Intraabdominal, not specified elsewhere**	**VASC**	**Arterial or venous infection**
IC	**Intracranial, brain abscess or dura**	**VCUF**	**Vaginal cuff**
JNT	**Joint or bursa**		

Appendix C: Recommended Case Definitions for Surveillance of Health Care-Associated Infections in Long-term Care Homes

[Source: McGeer A, Am J Infect Control 1991[44]]

Respiratory Tract Infection

Common cold syndromes/pharyngitis
The resident must have *at least two* of the following signs or symptoms:

1. runny nose or sneezing;
2. stuffy nose (i.e., congestion);
3. sore throat or hoarseness or difficulty in swallowing;
4. dry cough;
5. swollen or tender glands in the neck (cervical lymphadenopathy).

Comment: Fever may or may not be present. Symptoms must be new, and care must be taken to ensure that they are not caused by allergies.

Influenza-like illness
Both of the following criteria must be met:

1. Fever (≥38° C)*
2. The resident must have *at least three* of the following signs or symptoms:
   a) chills;
   b) new headache or eye pain;
   c) myalgias;
   d) malaise or loss of appetite;
   e) sore throat;
   f) new or increased dry cough.

*A single temperature of 38° C, taken at any site.

Comment: This diagnosis can be made only during influenza season (November to April in Canada). If criteria for influenza-like illness and another upper or lower respiratory tract infection are met at the same time, only the diagnosis of influenza-like illness should be recorded.

Pneumonia
Both of the following criteria must be met:

1. Interpretation of a chest radiograph as demonstrating pneumonia, probable pneumonia, or the presence of an infiltrate. If a previous radiograph exists for comparison, the infiltrate should be new.

2. The resident must have *at least two* of the signs and symptoms described under ‘‘other lower respiratory tract infections.’’

Comment: Non-infectious causes of symptoms must be ruled out. In particular, congestive heart failure may produce symptoms and signs similar to those of respiratory infections.

Other lower respiratory tract infection (bronchitis, tracheobronchitis)
The resident must have *at least three* of the following signs or symptoms:

1. new or increased cough;
2. new or increased sputum production;
3. fever (≥38° C);
4. pleuritic chest pain;
5. new or increased physical findings on chest examination (rales, rhonchi, wheezes, bronchial breathing);
6. *one* of the following indications of change in status or breathing difficulty:
    a) new/increased shortness of breath *or* respiratory rate ≥ 25 per minute; *or*
    b) worsening mental or functional status.*

* Significant deterioration in the resident's ability to carry out the activities of daily living or in the resident's cognitive status, respectively.

Comment: This diagnosis can be made only if no chest film was obtained or if a radiograph failed to confirm the presence of pneumonia.

Urinary Tract Infection

Urinary tract infection includes only symptomatic urinary tract infections. Surveillance for asymptomatic bacteriuria (defined as the presence of a positive urine culture in the absence of new signs and symptoms of urinary tract infection) is not recommended, as this represents baseline status for many residents.

Symptomatic urinary tract infection
One of the following criteria must be met:

1. The resident does not have an indwelling urinary catheter and has *at least three* of the following signs and symptoms:
    a) fever (≥38° C) or chills;
    b) new or increased burning pain on urination, frequency or urgency;
    c) new flank or suprapubic pain or tenderness;
    d) change in character of urine;†
    e) worsening of mental or functional status (may be new or increased incontinence).

2. The resident has an indwelling catheter and has *at least two* of the following signs or symptoms:
    a) fever (≥38° C) or chills;
    b) new flank or suprapubic pain or tenderness;
    c) change in character of urine;†
    d) worsening of mental or functional status.

† Change in character may be clinical (e.g., new bloody urine, foul smell, or amount of sediment) or as reported by the laboratory (new pyuria or microscopic hematuria). For laboratory changes, this means that a previous urinalysis must have been negative.

Comment: It should be noted that urine culture results are not included in the criteria. However, if an appropriately collected and processed urine specimen was sent and if the resident was not taking antibiotics at the time, then the culture must be reported as either positive or contaminated.

Because the most common occult infectious source of fever in catheterized residents is the urinary tract, the combination of fever and worsening mental or functional status in such residents meets the criteria for a urinary tract infection. However, particular care should be taken to rule out other causes of these symptoms. If a catheterized resident with only fever and worsening mental or

functional status meets the criteria for infection at a site other than the urinary tract, only the diagnosis of infection at this other site should be made.

Eye, Ear, Nose, and Mouth Infection

Conjunctivitis
One of the following criteria must be met:

1. Pus appearing from one or both eyes, present for at least 24 hours;
2. New or increased conjunctival redness, with or without itching or pain, present for at least 24 hours (also known as ‘‘pink eye’’).

Comment: Symptoms must not be due to allergy or trauma to the conjunctiva.

Ear infection
One of the following criteria must be met:

1. Diagnosis by a physician* of any ear infection;
2. New drainage from one or both ears (non-purulent drainage must be accompanied by additional symptoms, such as ear pain or redness).

* Requires a written note or a verbal report from a physician specifying the diagnosis. Usually implies direct assessment of the resident by a physician. An antibiotic order alone does *not* fulfill this criterion. In some homes, it may be appropriate also to accept a diagnosis made by other qualified clinicians (e.g., nurse practitioner, physician associate).

Mouth and perioral infection Oral and perioral infections, including oral candidiasis, must be diagnosed by a physician or a dentist.

Sinusitis
The diagnosis of sinusitis must be made by a physician.

Skin Infection

Cellulitis/soft tissue/wound infection
One of the following criteria must be met:

1. Pus present at a wound, skin, or soft tissue site;
2. The resident must have *four or more* of the following signs or symptoms:
   a) fever (>38° C) or worsening mental/functional status
      and/or, at the affected site, the presence of new or increasing
   b) heat,
   c) redness,
   d) swelling,
   e) tenderness or pain,
   f) serous drainage.

Fungal skin infection
The resident must have *both:*

1. a maculopapular rash; *and*

2. *either* physician diagnosis *or* laboratory confirmation.†

† For *Candida* or other yeast, laboratory confirmation includes positive smear for yeast or culture for *Candida* spp.; for herpetic infections, positive electron microscopy or culture of scraping or swab; for scabies, positive microscopic examination of scrapings.

Herpes simplex and herpes zoster infection.
For a diagnosis of cold sores or shingles, the resident must have *both*:

1. a vesicular rash; *and*
2. either physician diagnosis or laboratory confirmation.

Scabies
The resident must have *both:*

1. a maculopapular and/or itching rash; *and*
2. either physician diagnosis or laboratory confirmation.

Comment: Care must be taken to ensure that a rash is not allergic or secondary to skin irritation.

Gastrointestinal tract infection

Gastroenteritis
One of the following criteria must be met:

1. Two or more loose or watery stools above what is normal for the resident within a 24-hour period;
2. Two or more episodes of vomiting in a 24-hour period;
3. *Both* of the following:
   a) a stool culture positive for a pathogen (Salmonella, Shigella, E. coli O157:H7, Campylobacter) or a toxin assay positive for C. difficile toxin; *and*
   b) at least *one* symptom or sign compatible with gastrointestinal tract infection (nausea, vomiting, abdominal pain or tenderness, diarrhea).

Comment: Care must be taken to rule out non-infectious causes of symptoms. For instance, new medications may cause both diarrhea and vomiting; vomiting may be associated with gallbladder disease.

Systemic infection

Primary bloodstream infection
One of the following criteria must be met:

1. Two or more blood cultures positive for the same organism;
2. A single blood culture documented with an organism thought not to be a contaminant and *at least one* of the following:
   a) fever (≥38° C);
   b) new hypothermia (<34.5° C, or does not register on the thermometer being used);
   c) a drop in systolic blood pressure of . 30 mm Hg from baseline;
   d) worsening mental or functional status.

Comment: Bloodstream infections related to infection at another site are reported as secondary bloodstream infections and are not included as separate infections.

Unexplained febrile episode

The resident must have documentation in the medical record of fever (≥38° C) on two or more occasions at least 12 hours apart in any 3-day period, with no known infectious or non-infectious cause.

Appendix D: Sample Sentinel Surveillance Sheet

[Adapted from Sunnybrook Health Sciences Centre, Toronto, Ontario]

(To be completed by ward/unit staff each day)

Daily Surveillance Tool for FRI and Enteric Infections in Acute Care Patient Units

Date: _____ **Patient Unit:** _____ **Page** ____ **of** _____

- **Each shift is to update this form.**
- **Any <u>new</u> onset of symptoms of fever, cough, and shortness of breath, vomiting, diarrhea and/or pneumonia in patients must be reported to the attending physician <u>immediately</u> and a message for Infection Prevention & Control must be left.**

NAME/ HFN/ ROOM	ADMISSION DATE	DATE OF NEW ONSET	FEVER >38°C	COUGH	SOB	HYPOXIA (O^2 Sat <92%)	VOMITING	DIARRHEA	DROPLET PRECAUTIONS (YES OR NO)	ACTION (S)	INITIALS

Appendix E: Summary Sheet for Calculation of Infection Surveillance Rates

1. INCIDENCE DENSITY RATES (ADJUSTS FOR PATIENT/RESIDENT LENGTH OF STAY)

Example infections:

- AROs (infections and/or colonizations)
- Respiratory infections
- Skin and soft tissue infections

Number of cases over specified time period (e.g. surveillance quarter) x 10,000
Total number patient/resident days in hospital or facility over time period

2. DEVICE-ASSOCIATED INFECTION RATES

Example infections

- Central line-associated bloodstream infections
- Ventilator-associated pneumonias
- Indwelling catheter-associated urinary tract infections

Number of cases over specified time period (e.g. surveillance quarter) x 1000
Total number days that patients/residents were exposed to the device

3. SURGICAL SITE INFECTION RATES (SSIS)

Number of cases over specified time period following specific operative procedure x 100
Total number days that patients/residents underwent the same operative procedure in the same time period

Stratification of SSI rates by wound class

For Wound Classes I-II only:

Number of cases over specified time period following specific operative procedure x 100
Total number days that patients/residents underwent the same operative procedure in the same time period

For Wound Classes III-IV only:

Number of cases over specified time period following specific operative procedure x 100
Total number days that patients/residents underwent the same operative procedure in the same time period

Appendix F: Operative Procedure Categories and Corresponding ICD-9-CM Procedural Codes

[Reference: U.S. National Center for Health Statistics, International Classification of Diseases – Version 9 – Clinical Modification, Volume 3 (Procedures),[60] available online at: http://www.cdc.gov/nchs/about/otheract/icd9/abticd9.htm]

Code	Operative Procedure	Description	ICD-9-CM Codes
AAA	Abdominal aortic aneurysm repair	Resection of abdominal aorta with anastomosis or replacement	38.34, 38.44
AMP	Limb amputation	Total or partial amputation or disarticulation of the upper or lower limbs, including digits	84.00-84.19, 84.91
APPY	Appendix surgery	Operation of appendix (not incidental to another procedure)	47.01, 47.09, 47.2, 47.91-47.92, 47.99
AVSD	Shunt for dialysis	Arteriovenostomy for renal dialysis	39.27
BILI	Bile duct, liver or pancreatic surgery	Excision of bile ducts or operative procedures on the biliary tract, liver or pancreas (does not include operations only on gallbladder)	50.0, 50.12, 50.21-50.22, 50.29-50.3, 50.4, 50.61, 50.69, 51.31-51.37, 51.39, 51.41-51.43, 51.49, 51.51, 51.59, 51.61-51.63, 51.69, 51.71-51.72, 51.79, 51.81-51.83, 51.89, 51.91-51.95, 51.99, 52.09, 52.12, 52.22, 52.3, 52.4, 52.51-52.53, 52.59-52.6, 52.7, 52.92, 52.95-52.96, 52.99
BRST	Breast surgery	Excision of lesion or tissue of breast including radical, modified, or quadrant resection, lumpectomy, incisional biopsy, or mammoplasty.	85.12, 85.20-85.23, 85.31-85.36, 85.41-85.48, 85.50, 85.53-85.54, 85.6, 85.7, 85.93-85.96
CARD	Cardiac surgery	Open chest procedures on the valves or spetum of heart; does not include coronary artery bypass graft, surgery on vessels, heart transplantation, or pacemaker implantation	35.00-35.04, 35.10-35.14, 35.20-35.28, 35.31-35.35, 35.39, 35.42, 35.50-35.51, 35.53-35.54, 35.60-35.63, 35.70-35.73, 35.81-35.84, 35.91-35.95, 35.98-35.99, 37.10-37.11, 37.24-37.25, 37.31-37.35, 37.4-37.41, 37.49
CEA	Carotid endarterectomy	Carotid endarterectomy	38.12
CBGB	Coronary artery bypass graft with both chest and donor site incisions	Chest procedure to perform direct revascularization of the heart; includes obtaining suitable vein from donor site for grafting.	36.10-36.14, 36.19
CBGC	Coronary artery bypass graft with chest incision only	Chest procedure to perform direct vascularization of the heart using, for example the internal mammary (thoracic) artery	36.15-36.17, 36.2

Code	Operative Procedure	Description	ICD-9-CM Codes
CHOL	Gallbladder surgery	Cholecystectomy and cholecystotomy	51.03-51.04, 51.13, 51.21-51.24
COLO	Colon surgery	Incision, resection, or anastomosis of the large intestine; includes large-to-small and small-to-large bowel anastomosis; does not include rectal operations	45.03, 45.26, 45.41, 45.49, 45.52, 45.71-45.76, 45.79-45.8, 45.92-45.95, 46.03-46.04, 46.10-46.11, 46.13-46.14, 46.43, 46.52, 46.75-46.76, 46.94
CRAN	Craniotomy	Incision through the skull to excise, repair, or explore the brain; does not include taps or punctures	01.12, 01.14, 01.21-01.25, 01.31-01.32, 01.39, 01.41-01.42, 01.51-01.53, 01.59, 02.11-02.14, 02.91-02.93, 07.51-07.54, 07.59, 07.61-07.65, 07.68-07.69, 07.71-07.72, 07.79, 38.01, 38.11, 38.31, 38.41, 38.51, 38.61, 38.81, 39.28
CSEC	Cesarean section	Obstetrical delivery by Cesarean section	74.0, 74.1, 74.2, 74.4, 74.91, 74.99
FUSN	Spinal fusion	Immobilization of spinal column	81.00-81.08, 81.62-81.64, 84.51-84.52
FX	Open reduction of fracture	Open reduction of fracture or dislocation of long bones that requires internal or external fixation; does not include placement of joint prosthesis	79.21-79.22, 79.25-79.26, 79.31-79.32, 79.35-79.36, 79.51-79.52, 79.55-79.56
GAST	Gastric surgery	Incision or excision of stomach; includes subtotal or total gastrectomy; does not include vagotomy and fundoplication	43.0, 43.42, 43.49-43.5, 43.6, 43.7, 43.81, 43.89, 43.91, 43.99, 44.15, 44.21, 44.29, 44.31, 44.38-44.42, 44.49-44.5, 44.61-44.65, 44.68-44.69, 44.95-44.98
HER	Herniorrhaphy	Repair of inguinal, femoral, umbilical, or anterior abdominal wall hernia; does not include repair of diaphragmatic or hiatal hernia or hernias at other body sites.	53.00-53.05, 53.10-53.17, 53.21, 53.29, 53.31, 53.39, 53.41, 53.49, 53.51, 53.59, 53.61, 53.69
HPRO	Hip prosthesis	Arthroplasty of hip	00.70-00.73, 81.51-81.53
HTP	Heart transplant	Transplantation of heart	37.51-37.54
HYST	Abdominal hysterectomy	Removal of uterus through an abdominal incision	68.31, 68.39-68.4, 68.6,
KPRO	Knee prosthesis	Arthroplasty of knee	00.80-00.84, 81.54-81.55

THOR	Thoracic surgery	Noncardiac, nonvascular thoracic surgery; includes pneumonectomy and diaphragmatic or hiatal hernia repair	32.09-32.1, 32.21-32.22, 32.29-32.3, 32.4, 32.5, 32.6, 32.9, 33.0, 33.1, 33.28, 33.31-33.34, 33.39, 33.41-33.43, 33.48-33.49, 33.98-33.99, 34.01-34.03, 34.1, 34.26, 34.3, 34.4, 34.51, 34.59-34.6, 34.81-34.84, 34.89, 34.93, 34.99, 53.80-53.82
THYR	Thyroid and/or parathyroid surgery	Resection or manipulation of thyroid and/or parathyroid	06.02, 06.09, 06.12, 06.2, 06.31, 06.39-06.4, 06.50-06.52, 06.6, 06.7, 06.81, 06.89, 06.91-06.95, 06.98-06.99
VHYS	Vaginal hysterectomy	Removal of the uterus through vaginal or perineal incision	68.51, 68.59, 68.7
VSHN	Ventricular shunt	Ventricular shunt operations, including revision and removal of shunt	02.2, 02.31-02.35, 02.39, 02.42-02.43, 54.95
XLAP	Abdominal surgery	Abdominal operations not involving the gastrointestinal tract or biliary system	53.7, 54.0, 54.11-54.12, 54.19, 54.3, 54.4, 54.51, 54.59, 54.61-54.64, 54.71-54.75, 54.92-54.93
OTH	Other operations on the Nervous System		01.6, 02.01-02.07, 02.94-02.95, 02.99, 03.1, 03.29, 03.4, 03.51-03.53, 03.59-03.6, 03.71-03.72, 03.79, 03.97-03.98, 04.01-04.07, 04.12, 04.3, 04.41-04.44, 04.49-04.5, 04.6, 04.71-04.76, 04.79, 04.91, 05.0, 05.21-05.25, 05.29, 05.81, 05.89-05.9, 86.97-86.98
OTH	Other operations on the Endocrine System		07.00-07.02, 07.12, 07.21-07.22, 07.29-07.3, 07.41-07.45, 07.49, 07.80-07.82, 07.91-07.94, 07.99
OTH	Other operations on the Eye, Ear, Nose, Mouth, and Pharynx		08.01-08.02, 08.09, 08.20-08.25, 08.31-08.38, 08.41-08.44, 08.49, 08.51-08.52, 08.59, 08.61-08.64, 08.69-08.74, 08.81-08.87, 08.89, 09.20-09.23, 09.3, 09.6, 09.73, 09.81-09.83, 18.02, 18.09, 18.21, 18.29, 18.31, 18.39-18.4, 18.5, 18.6, 18.71-18.72, 18.79, 18.9, 20.21-20.23, 20.41-20.42, 20.49, 20.51, 20.59, 20.92, 20.95-20.99, 21.1, 21.30, 21.32, 21.4, 21.72, 21.82-21.87, 21.89, 22.12, 22.31, 22.39, 25.02, 26.12, 26.30-26.32, 27.55-27.57, 29.0, 29.2, 29.31-29.33, 29.39-29.4, 29.51-29.54, 29.59, 29.92
OTH	Other operations on the Respiratory System		30.09, 31.5, 31.61-31.64, 31.69, 31.71-

Code	Operative Procedure	Description	ICD-9-CM Codes
			68.9, 69.19, 69.21-69.23, 69.29-69.3, 69.41-69.42, 69.49, 70.4, 70.50-70.52, 70.61-70.62, 70.72-70.75, 70.8, 71.01, 71.09, 71.5, 71.61-71.62, 71.71-71.72, 71.79-71.8, 71.9,
OTH	Other Obstetrical Operations		74.3, 75.50, 75.52, 75.61-75.62, 75.93
OTH	Other operations on the Musculoskeletal System		00.74-00.76, 76.01, 76.09, 76.2, 76.31, 76.39, 76.41-76.46, 76.5, 76.61-76.70, 76.72, 76.74, 76.76-76.77,76.79, 76.91-76.92, 76.94, 76.97, 77.00-77.39, 77.51-77.54, 77.56-77.99, 78.00-78.09, 78.20, 78.22-78.25, 78.27-78.30, 78.32-78.35, 78.37-78.79, 78.90-78.99, 79.10-79.20, 79.23-79.24, 79.27-79.30, 79.33-79.34, 79.37-79.39, 79.50, 79.59-79.69, 79.80-79.99, 80.00-80.19, 80.40-80.49, 80.6, 80.70-80.99, 81.10-81.17-81.18, 81.20-81.29,81.40, 81.42-81.47, 81.49, 81.56-81.57, 81.59, 81.71-81.75, 81.79-81.85, 81.93-81.97, 82.01-82.04, 82.09, 82.11-82.12, 82.19, 82.21-82.22, 82.29, 82.31-82.36, 82.39, 82.41-82.46, 82.51-82.59, 82.61, 82.69, 82.71-82.72, 82.79, 82.81-82.86, 82.89, 82.91, 82.99, 83.01-83.03, 83.09,83.11-83.14, 83.19, 83.31-83.32, 83.39, 83.41-83.45, 83.49-83.50, 83.61-83.65, 83.71-83.77, 83.79, 83.81-83.89, 83.91-83.93, 84.21-84.30, 84.40, 84.44, 84.48, 84.53-84.55-84.58, 84.59, 84.92-84.93, 84.99
OTH	Other operations on the Integumentary System		85.00, 85.24-85.25, 85.82-85.87, 85.89, 85.99, 86.03-86.07, 86.09, 86.40, 86.60-86.63, 86.65-86.67, 86.69-86.75, 86.81-86.86, 86.89, 86.91, 86.93-86.96

Appendix G: Classification of Surgical Procedures According to Wound Class Risk

[Sources: Roy MC, Infect Control Hosp Epidemiol, 2000[64]; Friedman ND, Infect Control Hosp Epidemiol 2006[65]]

Wound Class	Definition	Examples	Risk of surgical site infection
Clean Surgery (I)	▪ Uninfected, uninflamed operative wound where muscosa of the respiratory, alimentary, genitourinary tract or oropharyngeal cavity are not transversed (i.e involves only sterile body sites) ▪ Insertion of prothesis or artificial device	▪ herniorraphy ▪ mastectomy ▪ cosmetic surgery ▪ Knee/hip replacement, heart valve	1-5%
Clean-contaminated Surgery (II)	Uninfected operative wound where the respiratory, alimentary, genital, or uninfected urinary tracts are entered	▪ Laryngectomy ▪ elective colorectal surgery ▪ uncomplicated appendectomy ▪ cholcystectomy ▪ transurethral resection of prostate gland	5-10%
Contaminated Surgery (III)	▪ Acute, nonpurulent, inflamed operative wound or open fresh, accidental wound ▪ An operative procedure with major breaks in sterile technique or gross spillage; macroscopic soiling of the operative field	▪ appendectomy for appendicitis ▪ Biliary or genitourinary tract surgery with infected bile or urine	10-15%
Dirty Surgery (IV)	Clinically infected operative wound or perforated viscera or old, traumatic wound with retained devitalized tissue, purulent draining	Repair of an open fracture that occurred three days earlier	> 25%

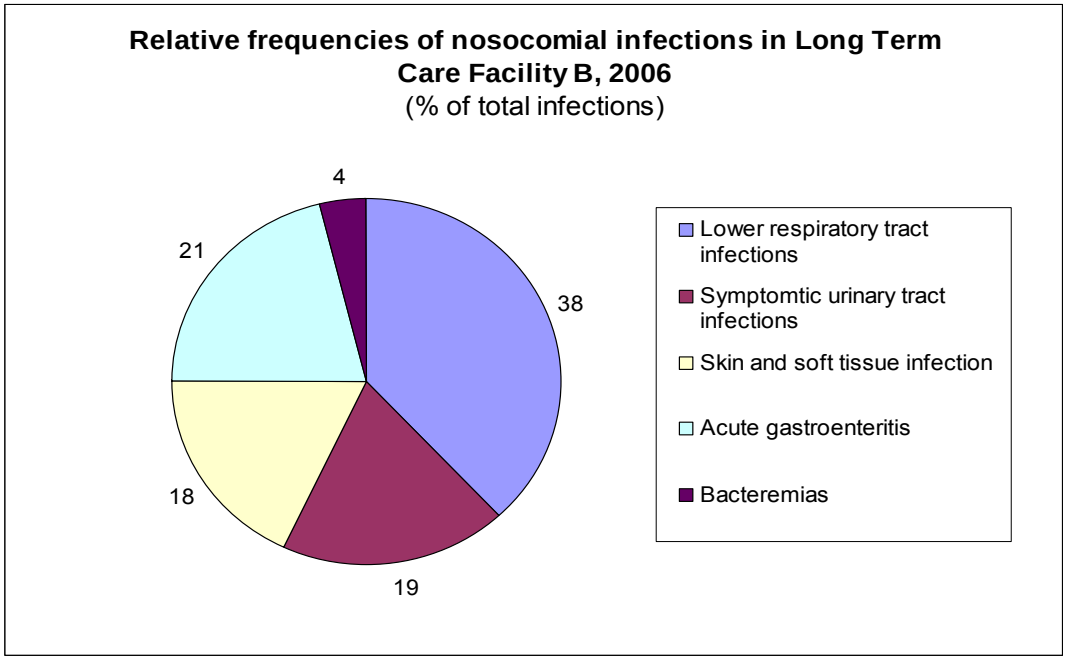
Appendix H: Tools for the Display of Surveillance Data

General guidelines for the presentation of data in graph or chart form are as follows:

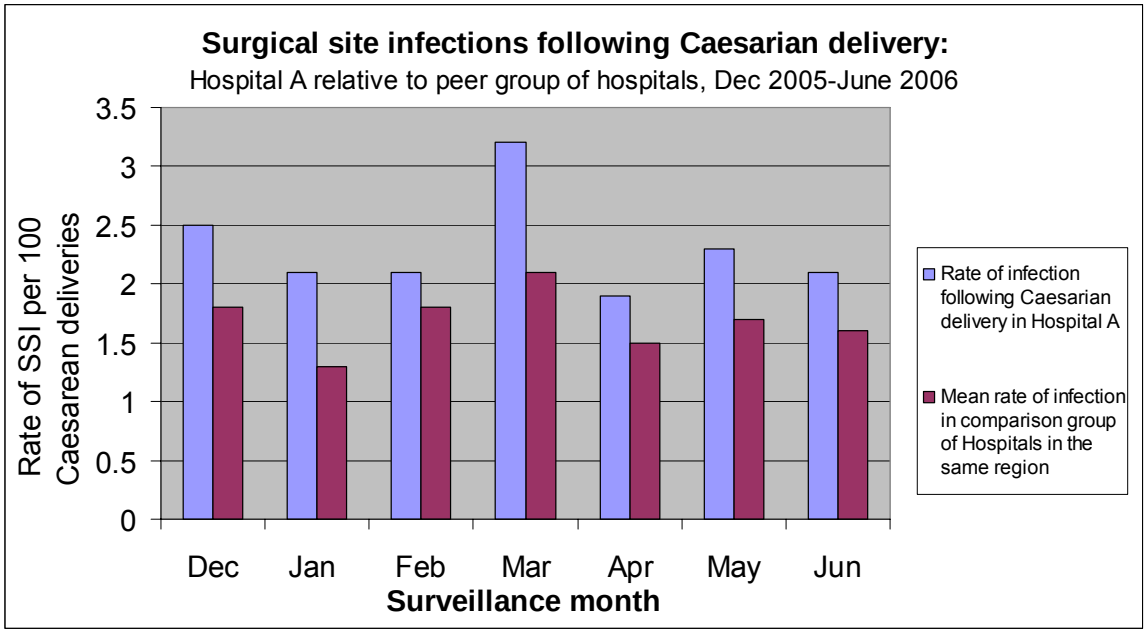
1. There should be a title (and sub-title, if necessary) that clearly outlines the data being presented.
2. For graphs and bar charts, the rate of infection is usually presented on the Y (or vertical) axis and the units of the scale should be constant (i.e. the scale units should not increase half-way up the axis).
3. The denominator should be clearly indicated (e.g. per 1000 resident days, per 1000 central line days).
4. Time is usually presented on the X (or horizontal) axis.
5. Graphs and charts should include a legend.
6. The use of colour often adds to a graph but coloured graphs should not lose their meaning when printed in black and white (e.g. for those printing surveillance reports on a black and white office printer).
7. The timeframe for the surveillance period should be clearly indicated on the graph (e.g. Surveillance Q1 (Jan-March 2006), Influenza season (Nov-Apr. 2007).
8. In some cases it may be useful to have a data table below the graph so that the reader can check the exact value.

The figures below provide examples of the visual display of surveillance data. Additional examples are provided in the document, Boxes 18 and 19.

Pie chart of data on nosocomial infection in a long-term care home



Bar graph displaying rates of procedure-specific surgical site infections with accompanying data tables:



	Dec	Jan	Feb	Mar	Apr	May	Jun
Rate of infection following Caesarean delivery in Hospital A per 100 Caesarean deliveries	2.5	2.1	2.1	3.2	1.9	2.3	2.1
Mean rate of infection in comparison group of hospitals in the same region per 100 Caesarean deliveries	1.8	1.3	1.8	2.1	1.5	1.7	1.6

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