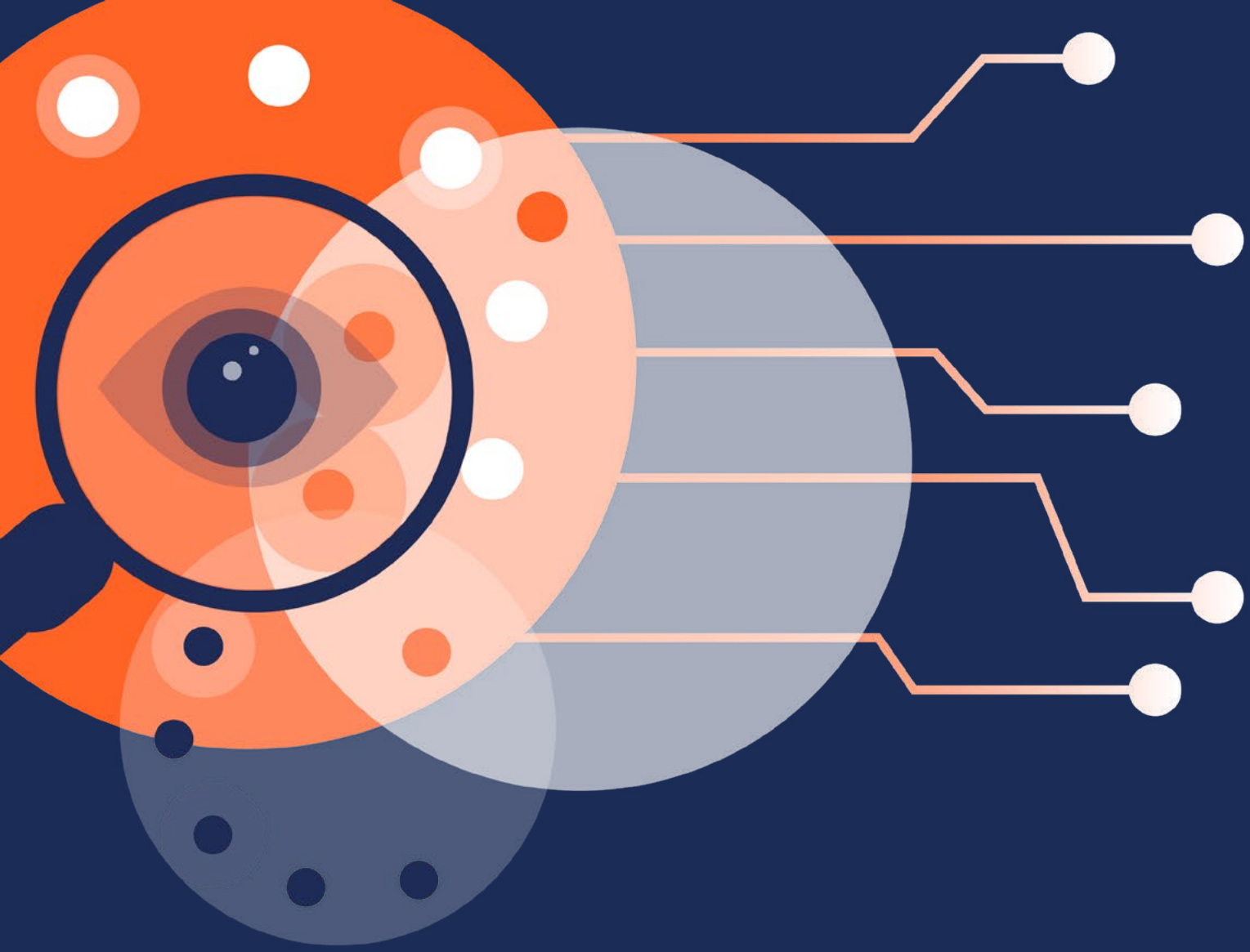

Surveillance of health care-associated infections at national and facility levels

Practical handbook

World Health Organization

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Contents

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Abbreviations and acronyms

AMR	antimicrobial resistance
BSI	bloodstream infection(s)
CAUTI	catheter-associated urinary tract infection(s)
CLABSI	central line-associated bloodstream infection(s)
COVID-19	coronavirus disease 2019
ECDC	European Centre for Disease Control and Prevention
EU/EEA	European Union/European Economic Area
EWAR	early warning, alert and response (systems)
GLASS	Global Antimicrobial Surveillance System
HAI	health care-associated infection(s)
HAP	health care-acquired pneumonia
HELICS	Hospitals in Europe Link for Infection Control through Surveillance
ICU	intensive care unit
IPC	infection prevention and control
IPCAF	Infection Prevention and Control Assessment Framework
IT	information technology
KISS	*Krankenhaus-Infektions-Surveillance-System* (Hospital-Infection-Surveillance-System)
LMICs	low- and middle-income countries
NHSN	National Health care Safety Network
PATH	Program for Appropriate Technology for Health
PRAISE	Providing a Roadmap for Automated Infection Surveillance
SMART	Specific, measurable, achievable, relevant and time-bound (objectives)
SSI	surgical site infection(s)
USA	United States of America
US CDC	United States Centers for Disease Control and Prevention
UTI	urinary tract infection(s)
VAP	ventilator-associated pneumonia
WHO	World Health Organization

Glossary of terms

Health care-associated infection: An infection occurring in a patient during the process of care in a hospital or other health care facility, which was not present or incubating at the time of admission. Health care-associated infections can also appear after discharge. They represent the most frequent adverse event associated with patient care.

Prevalence of HAI: This refers to the proportion of the patient population within a health care facility who have acquired an infection while receiving medical care.

Incidence of HAI: This refers to the rate or frequency of new infections that occur within a health care facility over a defined period of time.

Health information system: A system that collects data from health and other relevant sectors, analyses the data and ensures their overall quality, relevance and timeliness, and converts the data into information for health-related decision-making. It has four key functions: (i) data generation, (ii) compilation, (iii) analysis and synthesis, and (iv) communication and use. A solid health information system will be capable of generating reliable data from hospitals, outpatients, reportable diseases registries, cancer registries and other relevant data for health[1].

Digital surveillance systems for HAI: These are advanced technological systems designed to monitor, detect, and report infections acquired in health care settings.

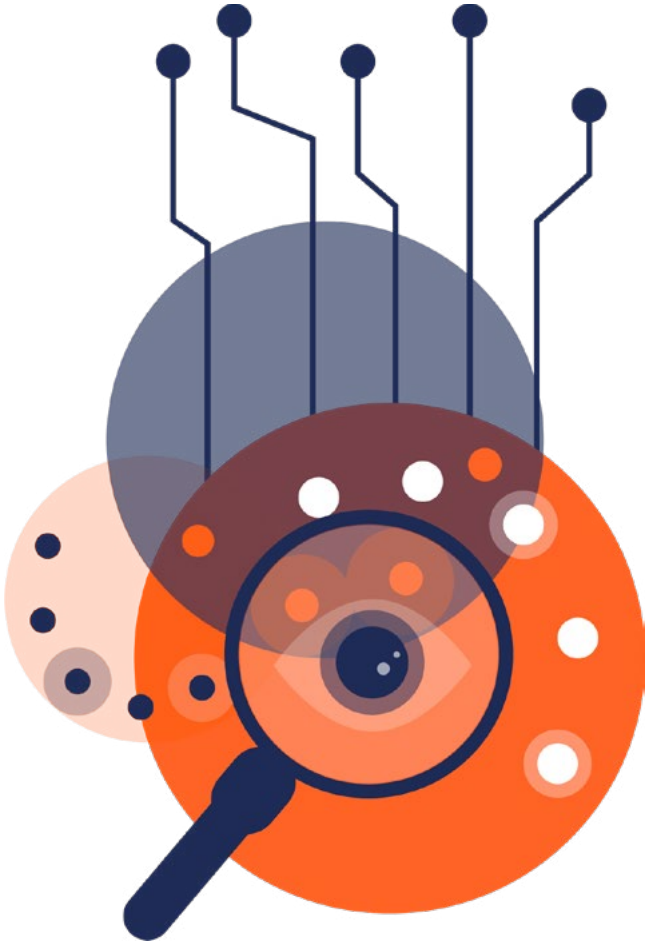
Low- and middle-income countries: WHO Member States are grouped into income groups (low, lower middle, upper-middle, and high) based on the World Bank list of analytical income classification of economies, calculated using the World Bank Atlas method. For the current 2024 fiscal year, low-income economies are defined as those with a gross national income per capita of US$ 1135 or less in 2022; lower middle-income economies as those with a gross national income per capita between US$ 1136 and US$ 4465; upper-middle-income economies are those with a gross national income per capita between US$ 4466 and US$ 13 845; high income economies are those with gross national income per capita of US$ 13 846 or more[2].

Surveillance: The ongoing, systematic collection, analysis, interpretation and evaluation of health data closely integrated with the timely dissemination of these data to those who need it.

1 WHO glossary of health data, statistics and public health indicators. Geneva: World Health Organization 2024 (glossary_of_terms_june-2024.pdf (who.int)).

2 World Bank country and lending groups. The World Bank Group. 2024 (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups).

Executive summary



Introduction

Health care-associated infections (HAI) are one of the most common adverse events in health care delivery and a major public health problem with an impact on morbidity, mortality and quality of life. On average, 7% of patients in developed and 15% in developing countries will acquire at least one HAI. These infections also present a significant economic burden at the societal level. Numerous reports from the World Health Organization (WHO) and other organizations have identified the increasing endemic burden of HAI and antimicrobial-resistant infections, which harm patients every day across health care systems in all countries worldwide, irrespective of income status. However, a large percentage of HAI are preventable through effective infection prevention and control (IPC) measures.

Purpose, scope and target audience

Improving HAI surveillance systems at national and facility level is crucial to guide efforts to reduce the burden of HAI. The purpose of this handbook is to provide a comprehensive overview of the objectives, key concepts, principles, methods, and best practices of HAI surveillance, with the aim to advise and help policy-makers and IPC and surveillance professionals to design and implement effective surveillance systems, to be able to measure the burden of HAI and take action towards its prevention. The content represents the latest available evidence on HAI surveillance and is aligned with WHO IPC documents already issued.

This handbook is primarily intended for those in charge of decision-making and policy formulation related to IPC and HAI surveillance at national, subnational and facility levels. This includes IPC leads and focal points who oversee IPC programmes and initiatives, HAI surveillance leads and teams, technical multidisciplinary HAI surveillance groups, national IPC committees, groups dedicated to IPC efforts and HAI surveillance, professionals developing or implementing IPC programmes, those tasked with creating, strengthening, or implementing IPC strategies, members or professionals with the mandate to develop and implement national action plans for combating antimicrobial resistance (AMR), infectious disease surveillance or notification systems staff, and those involved in quality, patient safety and accreditation programmes, including public health emergencies within the framework of the International Health Regulations.

Handbook development methodology

The development process of the handbook included review and use of existing WHO documents, consulting international experts, gathering input from colleagues in regional offices and the WHO

Antimicrobial Resistance (AMR) Division and Health Emergencies Programme, gathering comments by an external reviewer group comprised of national, regional, and international HAI surveillance experts.

WHO recommendations and guidance on health care-associated infections surveillance

WHO has consistently highlighted the significance of HAI surveillance systems as a vital and essential component of IPC in all its IPC-related policies and guidance documents. The most relevant recommendations, protocols and tools through which WHO has offered technical guidance to Member States on the methods for HAI surveillance and on systems for its implementation are the WHO guidelines on core components and the WHO minimum requirements for IPC programmes. Furthermore, the recently adopted WHO global strategy, action plan and monitoring framework for 2024–2030 provide guidance on establishing effective HAI surveillance systems and utilizing collected data to inform IPC improvement plans, actions and monitoring progress. Regarding protocols and training on HAI surveillance, so far WHO published a protocol and data collection forms for surgical site infection (SSI) surveillance and an online course available in several languages through OpenWHO.

Status of health care-associated infections surveillance systems in Member States

The WHO global report on IPC issued in 2022 highlighted that HAI surveillance remains one of the least implemented components of IPC programmes at both national and facility levels, particularly in low- and middle-income countries (LMICs). At health care facility level a WHO global survey conducted in 2019 using the WHO IPC assessment framework (IPCAF) tool revealed significant disparities in HAI surveillance implementation between low- and high-income countries, with weighted median scores of 12.5/100 versus 85/100, respectively.

Definition, epidemiology and burden of health care-associated infections

A general definition of HAI is an infection occurring in a patient during the process of care in a hospital or other health care setting, which was not present or incubating at the time of admission. Surveillance definitions of HAI are standardized criteria used to consistently identify and report HAI for monitoring and comparison purposes. Surveillance HAI definitions typically include specific clinical criteria, microbiological and radiological evidence, and a specified time frame (usually at least 48 hours from admission to the health care facility or care delivery) in which the infection must develop in relation to health care exposure or a specific health care intervention.

Recent reviews and studies on the frequency of HAI reported that the pooled prevalence of HAI was estimated to be 12.9% in the WHO South-East Asia Region, 9.7% in the WHO Western Pacific Region, 12.5% in the WHO Eastern Mediterranean Region, 27% in the WHO African Region, 8.0% in 28 European Union/European Economic Area (EU/EEA) countries and three Western Balkan countries, 9.6% in the WHO Region of the Americas, 3.2% in the United States of America (USA), and 7.9% in Canada. In intensive care units, up to 30% of patients can be affected by HAI, with an incidence that can be two to 20 times higher in LMICs than in high-income countries, particularly among neonates. Approximately one in four (23.6%) of all hospital-treated sepsis cases are HAI and almost one half (48.7%) of all cases of sepsis with organ dysfunction treated in adult ICUs are estimated to be acquired in the hospital. The European Centre for Disease Control and Prevention estimated that the burden of the six most frequent HAI was calculated to be twice the burden of 32 other infectious diseases all together in terms of disability and premature mortality. Global estimates of HAI frequency are hindered by underreporting, poor data quality, and a lack of standardized methods and protocols, resulting in a scarcity of reliable data, particularly in LMICs.

Common types of health care-associated infections

This handbook focuses on the four most frequent and commonly reported types of HAI: bloodstream infections (BSI), urinary tract infections (UTI), surgical site infection (SSI) and pneumonia.

Objectives of health care-associated infections surveillance systems

The ultimate goal of HAI surveillance systems is to improve the quality of health care, patient safety, patient outcomes, IPC decision-making, policy and research through the collection, analysis, and interpretation of critical data on HAI occurrence.

The primary objectives of HAI surveillance systems are to collect and analyse critical data on the occurrence of HAI.

Principles of health care-associated infections surveillance systems

At the national level, HAI surveillance is a key component of the IPC programme implementation. At the facility level, establishing and implementing an effective HAI surveillance system is crucial for improving patient outcomes and ensuring quality care. This is particularly important in secondary and tertiary care facilities. At both levels, there are some key principles that should guide the establishment and operation of HAI surveillance systems. These include: having a governance structure designating who is responsible for HAI surveillance and their roles and responsibilities; seeking integration with AMR and other surveillance systems; allocating adequate resources, including financial and human resources, to support the functioning and sustainability of the HAI surveillance systems and programmes; developing national and facility-level plans and protocols for HAI surveillance tailored to the local reality and aligned with national guidance; having monitoring and supervision mechanisms; establishing national and/or sub-national HAI surveillance networks; developing and implementing IPC action plans and interventions based upon findings from HAI surveillance.

Methods of health care-associated infections surveillance

The choice of the type of surveillance relies on various factors related to the status and capabilities of the IPC programme at national and facility levels, the experience and level of training of the professionals who will be responsible for implementing the surveillance, the clinical, laboratory, radiology and data management services available, and the information technology available at the country and health care facility level.

Active surveillance is the best option to identify and detect HAI. In active surveillance, data are specifically collected for the purpose of surveillance, usually prospectively, by trained personnel searching for infections according to HAI case definitions. *Passive surveillance* relies on data sources not specifically intended for surveillance and is often retrospective and not conducted by trained surveillance staff. However, although this method is less demanding than active surveillance and may be the only feasible method in settings that lack expertise in surveillance and resources, it is the least sensitive way to detect infections.

Patient-based surveillance links the laboratory with clinical data and patient information. It estimates the frequency of HAI and assesses risk factors. Patient-based surveillance requires visits to patient care areas and review of patient medical charts and records.

A *laboratory-based surveillance* means that infection identification is based solely on positive laboratory findings from the patient's clinical specimens (blood, urine, swab, etc.), without a link to patient clinical records, results of other diagnostic tests (for example, X-ray or others), or patient characteristics. This type of surveillance describes the pathogens and their resistance pattern detected by the hospital laboratory and can help identify the most frequently isolated pathogens in inpatients and the extent of AMR within the health care facility.

Health care facility populations under surveillance can differ according to the specified national and facility level objectives of the HAI surveillance plan. Two approaches can be considered: (1) *comprehensive or facility-wide surveillance* where all patients are observed (that is, all patient populations under surveillance) versus (2) *targeted or focused surveillance* where selected wards, patients or types of HAI are observed (for example, specific patient populations or specific HAI are deemed particularly relevant to put under surveillance).

The *prevalence of HAI* refers to the proportion of the patient population within a health care facility who have acquired an infection while receiving medical care. It is typically expressed as a percentage (proportion). Data from each patient are collected only once during the time of the survey. Prevalence surveys can be repeated at regular intervals to show change. They may be quicker and less expensive than incidence.

The *incidence of HAI* refers to the rate or frequency of new infections that occur within a health care facility over a defined period of time. Conducting surveillance using incidence is prospective, more reliable, but resource intensive, as it requires well-trained and dedicated teams to systematically screen entire patient charts and perform data collection and interpretation. Prospective incidence surveys are the best way to track trends of HAI over time and to study specific types of infection which require follow-up with patients at risk.

Essential elements and best practices of health care-associated infections surveillance

Six essential elements of HAI surveillance exist which are similar to public health surveillance programmes for infectious diseases. These are: surveillance planning; data collection; analysis; interpretation; communication; and monitoring and evaluation.

Key aspects of each of these elements are described in the following table, according to the national and the health care facility level.

Summary of HAI surveillance best practices at national and facility levels by surveillance element*

National-level best practices	Facility-level best practices
Develop a national-level HAI surveillance plan including the items given below.	Develop a facility-level HAI surveillance plan in alignment with the national plan including the items given below.
HAI surveillance planning	
National-level best practices	**Facility-level best practices**
Determine who is responsible for HAI surveillance.	Determine who is responsible for HAI surveillance.
Establish goals and objectives of HAI.	Establish goals and objectives of HAI surveillance.
Allocate resources.	Allocate resources.
Identify methods of HAI surveillance.	Define methods of HAI surveillance in alignment with national methods.
Identify types of HAI to be assessed.	Identify facility priority types of HAI within the context of the national types of infections
Agree on standardized HAI case definitions.	Use national HAI surveillance case definitions
Select health care facilities to conduct HAI surveillance.	
Determine the time period of HAI surveillance.	Follow the recommendations of the national HAI strategic plan.
Facilitate the exchange of HAI surveillance information between facilities to share experiences and training.	Facility administration should promote collaboration among IPC/HAI surveillance and health care staff through meetings, webinars, etc.
Data collection of HAI surveillance data	
National-level best practices	**Facility-level best practices**
Develop standardized HAI surveillance data collection protocols and tools.	Follow the national standardized HAI surveillance data collection protocols.
Suggest who should be responsible for HAI surveillance data collection at facility level.	Identify who is responsible for HAI surveillance data collection at facility level.
Identify sources of HAI surveillance data collection at facility level.	Identify facility sources of HAI surveillance data collection.
Establish reporting mechanisms and structure for reporting HAI surveillance data from health care facilities to the national level.	Provide and share HAI surveillance data in a way consistent with the national HAI surveillance database structure.
Check quality of HAI surveillance data received.	Check and improve quality of HAI surveillance data.
Develop a national HAI surveillance database to aggregate surveillance data received from health care facilities.	Develop a facility HAI surveillance database.
Provide continuous training and education to health care facilities in HAI surveillance data collection protocols and procedures.	Ensure that the facility IPC/HAI surveillance team are well trained in HAI surveillance data collection.
Ensure compliance with relevant laws and ethical standards for data collection.	Ensure compliance with national ethical standards for data collection.

Summary of HAI surveillance best practices at national and facility levels by surveillance element (continued)

Analysis of HAI surveillance data	
National-level best practices	**Facility-level best practices**
Analyse HAI surveillance data at national level on regular basis (at least once annually).	Analyse HAI surveillance data on a regular basis (monthly or quarterly).
Identify national HAI indicators.	Focus on key metrics relevant to the facility.
Training of data analysts at national and facility levels.	Facility-level data analysts should utilize basic analytic tools, calculations and simple metrics.
Interpretation of HAI surveillance data	
National-level best practices	**Facility-level best practices**
Contextualize HAI surveillance data within the broad context of national health trends.	Contextualize HAI surveillance data within the context of the health care facility and engage frontline staff in the interpretation process.
Identify patterns and trends of infections to identify emerging threats or areas needing interventions.	Monitor infection trends over time within the facility to detect changes in HAI rates and to assess the impact of interventions.
	Explore the underlying aetiology of the high infection rates (if any).
Benchmark national HAI surveillance data against international benchmarks.	Benchmark facility-level HAI surveillance data against other facilities.
Interpret HAI surveillance data within existing national IPC policies and guidelines	Interpret HAI surveillance data within existing facility-level IPC policies and guidelines and continuously adjust IPC strategies.
	Translate HAI surveillance data into actionable IPC recommendations and interventions.
Communication/feedback of HAI surveillance data	
National-level best practices	**Facility-level best practices**
Develop a national HAI surveillance communication/feedback plan.	Develop a facility-level HAI surveillance communication/feedback plan.
Identify the national- and facility-level stakeholders to communicate with and share the HAI surveillance results.	Identify the facility-level stakeholders to communicate with and share the HAI surveillance results.
Develop national HAI surveillance reports, including important national summaries of HAI surveillance data.	Develop facility-level HAI surveillance reports to summarize facility-level HAI surveillance data.
Engage with national stakeholders through meetings, webinars, and workshops.	Engage with facility stakeholders through meetings and webinars to discuss HAI surveillance results.
Make HAI surveillance data publicly available (if possible) while ensuring patient confidentiality.	Publish HAI surveillance data at the facility level.
Distribute the national HAI surveillance report to national and facility stakeholders.	Distribute the HAI surveillance report to facility stakeholders in a timely manner.

Summary of HAI surveillance best practices at national and facility levels by surveillance element (continued)

Provide tailored feedback to health care facilities including specific IPC recommendations for improvement.	Provide tailored feedback to facility stakeholders, including specific IPC recommendations for improvement.
Incorporate HAI surveillance findings in the training and education programmes for health care workers.	Incorporate HAI surveillance findings in the training and education programmes for health care workers.
Monitoring and evaluation of HAI surveillance	
National-level best practices	**Facility-level best practices**
Implement periodic reviews of the HAI surveillance system elements on a regular basis.	Implement periodic reviews of the HAI surveillance system elements on a regular basis.
Assess health care facilities' adherence to surveillance protocols, timeliness of data collection, analysis, reporting requirements and dissemination.	Assess adherence of the facility to all HAI surveillance elements.
Conduct continuous HAI surveillance system updates to incorporate new technologies, and best practices.	Use monitoring and evaluation results to update and modify the HAI surveillance system so as to incorporate new technologies and best practices.
Evaluate the impact of HAI surveillance on the reduction of HAI.	Evaluate the impact of HAI surveillance on the reduction of HAI.
Share results of evaluations with national stakeholders.	Share results of evaluations with facility-level stakeholders.
Utilize evaluation findings to inform future planning.	Utilize evaluation findings to guide continuous improvement efforts and inform future planning.

Abbreviations: IPC, infection prevention and control; HAI, health care-associated infection(s).

** This table corresponds to Table 6, page 36 in the main text..*

Health care-associated infections surveillance and public health emergencies

Effective HAI surveillance is crucial for early detection, containment and mitigation of health care-associated outbreaks to ensure the safety of patients and health and care workers. The objectives of HAI surveillance during public health emergencies are: early detection of cases and outbreaks; understanding the burden of HAI; informing IPC strategies; ensuring rational resource allocation; using incidence and outbreak investigation data to guide decision-making, resource allocation and policy formulation during outbreak response and recovery. HAI surveillance integration with early warning, alert and response systems is critical to generate alerts for suspected HAI, thus enabling a timely notification of cases and outbreaks during public health emergencies and incorporating IPC measures to ensure safe screening practices and protocols for immediate implementation upon identification of suspected cases.

New WHO health care-associated infections surveillance case definitions

Standardized and validated HAI case definitions are essential for effective surveillance and monitoring of HAI. Until now, no universally agreed-upon, standardized HAI case definitions for global use have been available, in particular for low-resource settings. The United States Centers for Disease Control and Prevention (US CDC) and the European Centre for Disease Prevention and Control (ECDC) offer standardized HAI surveillance definitions, which are widely used in many countries. However, these

definitions rely on a level of laboratory, diagnostic, imaging and epidemiological capacity that may not be achievable in low-resource settings. To address the limitations of applying the available standardized HAI case definitions, such as those from US CDC and ECDC, in settings with limited resources, WHO developed simplified case definitions for HAI surveillance, for use in these settings. Development was based on the standardized US and ECDC definitions and expert consensus; the draft definitions were validated by undertaking a concordance study through a point prevalence survey to compare WHO definitions to the ECDC definitions. Based on the overall high level of concordance between WHO simplified definitions and ECDC HAI definitions, international experts agreed by a very large consensus (90% of agreement or above) that the WHO definitions can be accepted and used. The new WHO definitions cover the four most frequent and commonly reported types of HAI, namely BSI, SSI, UTI and pneumonia, and are presented in the following table.

WHO HAI case definitions for use in settings with limited resources*

Bloodstream infection(s) (BSI)
Confirmed BSI (BSI-A1) One positive blood culture for a recognized pathogen. It excludes common skin commensals such as coagulase-negative staphylococci, *Micrococcus* sp., *Propionibacterium acnes*, *Bacillus* sp., *Corynebacterium* sp.
Confirmed BSI (BSI-A2) Patient has at least one of the following signs or symptoms: fever (> 38°C) ***OR*** chills ***OR*** hypotension (systolic pressure ≤ 90 mmHg); ***AND*** two positive blood cultures for a common skin commensal(s) (from two separate blood samples) within 48 hours. Common skin contaminants include coagulase-negative staphylococci, *Micrococcus* sp., *Propionibacterium acnes*, *Bacillus* sp., *Corynebacterium* sp.
Suspected BSI (BSI-B) Patient has at least one of the following signs or symptoms: fever (> 38°C) ***OR*** chills ***OR*** hypotension (systolic pressure ≤ 90 mmHg); ***AND*** treatment for infection is instituted (that is, on the day of sample collection, physician documentation of antimicrobial treatment for suspected infection); ***AND*** one positive blood culture for a common skin commensal(s). Common skin contaminants include coagulase-negative staphylococci, *Micrococcus* sp., *Propionibacterium acnes*, *Bacillus* sp., *Corynebacterium* sp.
Central vascular catheter-associated BSI (CVC-BSI) BSI-A1 ***OR*** BSI-A2 ***OR*** BSI-B definition met ***AND*** a central vascular catheter in place ≤ 2 days prior to first meeting a component of the confirmed BSI definition.

WHO HAI case definitions for use in settings with limited resources (continued)

Suspected unidentified systemic infection (SUSI)

Patient has at least one of the following signs or symptoms: fever (> 38°C) ***OR*** chills ***OR*** hypotension (systolic pressure ≤ 90 mmHg);

AND

treatment for infection is instituted (physician documentation of antimicrobial treatment for suspected infection);

AND

blood culture not done .

Urinary tract infection(s) (UTI)

Microbiologically-confirmed symptomatic UTI (UTI-A)

Patient has at least one of the following signs or symptoms with no other recognized cause: fever (> 38°C); ***OR*** urinary urgency; ***OR*** increased urinary frequency; ***OR*** dysuria; ***OR*** flank pain; ***OR*** supra-pubic pain; ***OR*** suprapubic tenderness;

AND

a positive urine culture (≥ 10^5 microorganisms per mL of urine with no more than two species of microorganisms).

Not microbiologically-confirmed symptomatic UTI (UTI-B)

Patient has at least two of the following signs or symptoms with no other recognized cause: fever (> 38°C); ***OR*** urinary urgency; ***OR*** increased urinary frequency; ***OR*** dysuria; ***OR*** flank pain; ***OR*** supra-pubic pain; ***OR*** suprapubic tenderness;

AND

at least one of the following findings: positive dipstick for leukocyte esterase and/or nitrate; ***OR*** pyuria with ≥ 10 white blood cell (WBC)/mL or ≥ 3 WBC/high-power field of unspun urine; ***OR*** microorganisms seen on Gram stain of unspun urine; ***OR*** at least two urine cultures with repeated isolation of the same uropathogen (Gram-negative bacteria or *Staphylococcus saprophyticus*) with ≥ 10^2 colonies/mL urine in non-voided specimens; ***OR*** ≤ 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 UTI.

Not microbiologically-confirmed symptomatic UTI (UTI-C)

Patient has at least three of the following signs or symptoms with no other recognized cause: fever (> 38°C); ***OR*** urinary urgency; ***OR*** increased urinary frequency; ***OR*** dysuria; ***OR*** flank pain; ***OR*** supra-pubic pain; ***OR*** suprapubic tenderness;

AND

clinician diagnosis of a UTI ***OR*** clinician institutes therapy for a UTI.

Catheter-associated UTI (CAUTI)

UTI-A ***OR*** UTI-B ***OR*** UTI-C definitions;

AND

an indwelling urinary tract catheter in place ≤ 2 days prior to first meeting a component of the confirmed UTI definition.

WHO HAI case definitions for use in settings with limited resources (continued)

Surgical site infection(s) (SSI)

SSI type A (SSI-A)

Postoperative patients within 30 days following a surgical procedure with evidence of SSI based on microbiology (for positive culture); ***OR*** radiology (suggestive of infection); ***OR*** histopathologic criteria (for abscess or similar findings).

Stratify by depth if the following information is available:

a) superficial: AND infection involves only skin and subcutaneous tissue of the incision;

b) deep incisional: AND infection involves deep soft tissue (for example, fascia, muscle) of the incision;

c) organ/space: AND infection involves any part of the anatomy (for example, organs and spaces) other than the incision that was opened or manipulated during a surgical procedure.

SSI type B (SSI-B)

Postoperative patients within 30 days following a surgical procedure with reopening of the wound for suspected infection ***OR*** abscess (or similar findings) found during direct examination or during reoperation (for deep and organ/space SSI).

Stratify by depth if the following information is available:

a) superficial: AND infection involves only skin and subcutaneous tissue of the incision;

b) deep incisional: AND infection involves deep soft tissue (for example, fascia, muscle) of the incision;

c) organ/space: AND infection involves any part of the anatomy (for example, organs and spaces) other than the incision that was opened or manipulated during a surgical procedure.

SSI type C (SSI-C)

Postoperative patients within 30 days following a surgical procedure with evidence of purulent discharge at the incision or surgical site.

Stratify by depth if the following information is available:

a) superficial: AND infection involves only skin and subcutaneous tissue of the incision;

b) deep incisional: AND infection involves deep soft tissue (for example, fascia, muscle) of the incision;

c) organ/space: AND infection involves any part of the anatomy (for example, organs and spaces) other than the incision that was opened or manipulated during a surgical procedure.

SSI type D (SSI-D)

Postoperative patient within 30 days following a surgical procedure;

AND

diagnosis of an SSI is made by the surgeon or attending physician or designee.

WHO HAI case definitions for use in settings with limited resources (continued)

Pneumonia (PNM)
Microbiologically-confirmed PNM (PNM-A)
Patient has at least two of the following: fever (>38°C); ***OR*** cough; ***OR*** purulent sputum; ***OR*** tachypnoea (respiratory rate >20 bpm); ***OR*** worsening gas exchange (SpO_2<94% or decrease from baseline of >3%, new or increased need for supplemental O_2); ***OR*** documented auscultation indicative of pneumonia; ***OR*** compatible findings such as "crackles" or "bronchial breath sounds"; ***AND*** chest X-ray ***OR*** computed tomography (CT) scan suggestive of pneumonia; ***AND*** microorganisms isolated from any positive microbiology from the respiratory sample (quantitative or non-quantitative, including serology, antigen in urine, etc.); ***AND/OR*** blood culture.
Radiologically-confirmed PNM (PNM-B)
Patient has at least two of the following: fever (>38°C); ***OR*** cough; ***OR*** purulent sputum; ***OR*** tachypnoea (respiratory rate > 20 bpm); ***OR*** worsening gas exchange (SpO_2<94% or decrease from baseline of >3%, new or increased need for supplemental O_2); ***OR*** documented auscultation indicative of pneumonia; ***OR*** compatible findings such as "crackles" or "bronchial breath sounds"; ***AND*** chest X-ray ***OR*** CT scan suggestive of pneumonia.
Clinical PNM (PNM-C)
Patient has at least three of the following: fever (>38^{O}C); ***OR*** cough; ***OR*** purulent sputum; ***OR*** tachypnoea (respiratory rate > 20 bpm); ***OR*** worsening gas exchange (SpO_2<94% or decrease from baseline of >3% or new or increased need for supplemental O_2); ***OR*** documented auscultation indicative of pneumonia; ***OR*** compatible findings such as "crackles" or "bronchial breath sounds".
Ventilator-associated pneumonia (VAP)
PNM-A ***OR*** PNM-B ***OR*** PNM-C; ***AND*** mechanical ventilation/intubation in place ≤ 2 days prior to first meeting a component of the pneumonia definition.

** This table corresponds to the Annex 1 on page 58 in the main text.*

This handbook addresses additional considerations for HAI surveillance systems.

Surveillance case definitions versus clinical diagnosis

Both HAI surveillance case definitions and clinical diagnosis involve identifying infections in health care facilities. However, they serve different purposes, have different criteria, and are used in different contexts within health care settings as indicated in the following table.

Comparison between HAI surveillance case definitions and clinical diagnosis*

	HAI surveillance case definitions	Clinical diagnosis
Purpose	For surveillance and public health purposes.	To guide patient care.
Objective versus subjective	Aims to apply objective criteria.	Applies all available subjective and objective criteria.
Population versus individual	Population level.	Individual level.
Consistency versus accuracy	Consistent.	Accurate.
Temporal aspect	May include a temporal aspect.	Focuses on the current clinical presentation of the patient.

** This table corresponds to Table 7, p42.*

Political leadership, regulatory considerations and public reporting

Demonstrating visible leadership engagement at the highest level, is one of the most important elements to successfully achieve effective implementation of the WHO IPC core components and thus will have a great influence on the success of national HAI surveillance systems.

Regulatory considerations and public reporting

The enforcement of the IPC core components, particularly HAI surveillance, should be enabled through legal health systems' regulations, accountability frameworks and accreditation systems. To support these, mobilizing national resources is not only crucial for the sustained financing of IPC programmes, but also essential to accelerate the sustainable implementation of the IPC programme. Examples of legal instruments are a constitution, acts of legislation such as laws and decrees, regulations, and applicable international agreements.

Public reporting of HAI surveillance data is used in some countries with the purpose to increase transparency and data sharing.

Digital or automated surveillance systems

Digitalization of health care data creates novel opportunities for enhancing HAI surveillance. Digital tools can support HAI surveillance in different ways.

Decision-supported IT digital applications can be used for handling HAI surveillance data (for example, presence of individual criteria) and decision algorithms can help to define the various types of HAI according to the used HAI case definitions. Other digital IPC tools focus on the implementation and

evaluation of IPC measures. Moreover, digital applications can be developed to have the ability to define and generate automated alerts when certain conditions are met (for example, detection of emerging pathogens). Digital applications can also be developed to support the electronic transfer of data from facilities to the national level and to facilitate the merge of facility-level data into the national HAI database.

Automated surveillance systems offer the potential to overcome the limitations of 'manual' surveillance of HAI which is usually done through a manual review of patients' medical records, by providing mechanisms to include more health care areas, patients and infections into the surveillance and by being more reproducible. Automated surveillance systems vary in complexity, functionality and implementation requirements. Fully automated and semi-automated surveillance systems exist. Most automated surveillance methods to detect HAI have been developed and implemented in research settings and information about the feasibility of large-scale implementation is scarce. Development of large-scale national automated surveillance systems is a promising option that can support the uniform collection of surveillance data across facilities, while also being suitable for quality improvement at the facility level. However, several aspects should be considered when developing national automated surveillance systems, such as privacy, data sharing, data security and protection ethical considerations, laws and regulations on data reporting.

Challenges and solutions for health care-associated infections surveillance

Designing and implementing HAI surveillance systems involve various challenges which can differ based on health care system structures, infection control practices, and available resources. In low- and middle-income countries, more challenges are anticipated related to limited political support, insufficient national budgets and competing health care priorities. Other barriers include understaffing, shortages of basic laboratory equipment and insufficient quality of the microbiology laboratory results, and limited motivation to report HAI. The most significant challenges for HAI surveillance include a lack of expertise to conduct HAI surveillance and the need for substantial financial investment, in particular in settings with limited resources.

Many country examples and international stakeholder initiatives have indicated that some solutions can be found to addressing the challenges of HAI surveillance. These usually require a multifaceted approach that should include, among other elements, securing resources, building capacity and strengthening the health system. This handbook provides details about solutions to achieve the successful development and implementation of an HAI surveillance system, as well as insightful country examples.

1. Purpose

This handbook provides a comprehensive overview of the objectives, key concepts, principles, methodologies, elements, and best practices of health care-associated infection (HAI) surveillance to help establish robust national and facility-level HAI surveillance systems. The content represents the latest available evidence on HAI surveillance and is aligned with the World Health Organization (WHO) infection prevention and control (IPC) documents already published.

It aims to provide guidance how to design and implement effective surveillance strategies to measure the burden of HAI, enhance IPC to reduce HAI, and improve overall health outcomes.

2. Target audience

The intended audience for this handbook is primarily those persons in charge of decision-making and policy formulation related to IPC and HAI surveillance at national, subnational and facility levels, including:

- IPC leads and focal points who oversee IPC programmes and initiatives;
- HAI multidisciplinary groups and IPC national committees dedicated to IPC;
- groups dedicated to IPC efforts and HAI surveillance at various levels of health care;
- professionals developing, strengthening, or implementing IPC programme and strategies;
- members or professionals with the mandate to develop and implement national action plans for combating antimicrobial resistance (AMR);
- infectious disease surveillance or notification systems staff, those involved in quality, patient safety and accreditation programmes, including public health emergencies within the framework of the International Health Regulations.

3. Handbook development methodology

The development of the handbook was based on the following steps:

1. Development of an initial outline of content by the leading authors and discussion with external experts.
2. Desk review for the identification of existing WHO documents and training resources including recommendations and guidance on HAI surveillance *(1–6).*
3. Development of a first draft using WHO documents, training resources *(7),* and meeting reports of WHO international consultations, discussing and including HAI surveillance topics.
4. Review of the first draft by members of the WHO IPC Unit team in Geneva, Switzerland, along with some external experts.
5. Development of a second draft, which was shared with all regional IPC leads and focal points, members of the WHO Antimicrobial Resistance (AMR) Division and Health Emergencies Programme, who all provided feedback and comments.
6. Development of a third draft capturing all comments received.
7. Process of peer review by an external reviewer group comprised of national, regional and international HAI surveillance experts.
8. Development of the final version of the handbook on HAI surveillance.

4. Background on WHO recommendations and guidance on health care-associated infections surveillance

WHO has consistently highlighted the significance of HAI surveillance systems as a vital and essential component of IPC in all its IPC-related policies and guidance documents. The most relevant recommendations, protocols and tools through which WHO has offered technical guidance to Member States on the methods for HAI surveillance and on systems for its implementation are summarized in this chapter.

4.1 WHO guidelines on core components and minimum requirements of infection, prevention and control programmes

In 2016, WHO issued the WHO guidelines on core components of IPC programmes at the national and acute health care facility level *(1).* These guidelines provide evidence-based recommendations to help countries establish effective IPC programmes at both national and facility levels, with the aim to prevent the transmission of HAI and combat AMR.

A critical focus of these guidelines is core component 4, which focuses on HAI surveillance. It strongly recommends that national HAI surveillance programmes and networks be established and incorporate timely data feedback mechanisms in order to monitor progress on HAI and AMR prevention, including potential use for benchmarking purposes, and subsequently reduce their occurrence. At the facility level, these guidelines advocate for facility-based HAI surveillance to guide IPC interventions, detect outbreaks, and conduct AMR surveillance with timely feedback to health care workers and stakeholders.

Recognizing the challenges faced by low- and middle-income countries (LMIC) in implementing all IPC core components, WHO published an additional document in 2019 detailing minimum requirements for each core component. Both the 2016 and 2019 WHO documents underscore the importance of HAI surveillance in reducing HAI and improving health care quality and patient safety *(1, 2)*. Table 1 outlines the WHO core component 4 recommendations and minimum requirements for HAI surveillance systems at national and facility levels.

4.2 WHO infection, prevention and control global strategy, action plan and monitoring framework

In May 2023, WHO presented and adopted its global strategy on IPC at the 76th World Health Assembly. This strategy aims to strengthen IPC programmes across all health care settings, including acute and long-term care, as well as primary, secondary and tertiary facilities in both the public and private sectors. The vision is that "*by 2030, everyone accessing or providing health care is safe from associated infections*". Among the eight strategic directions, fifth, "data for action," focuses on HAI surveillance (Fig. 1). The latter direction provides guidance on establishing effective surveillance systems and utilizing collected data to inform IPC improvement actions.

Following the adoption of the global strategy, WHO developed an IPC action plan and monitoring framework for 2024—2030, approved at the 77th World Health Assembly in May 2024. The backbone of this document are the eight strategic directions included in the global strategy; the global action plan and monitoring framework indicates actions, indicators and targets that are necessary to follow each strategic direction and achieve the global strategy objectives. A key focus is on HAI surveillance, emphasizing the need for national HAI and AMR strategic plans and systems.

Table 1. WHO core component 4 recommendations and minimum requirements for HAI surveillance at national and facility levels *(1,2)*.

CORE COMPONENT 4:
HAI SURVEILLANCE

	NATIONAL LEVEL	FACILITY LEVEL
CORE COMPONENT RECOMMENDATION	The panel recommends that national HAI surveillance programmes and networks that include mechanisms for timely data feedback and with the potential to be used for benchmarking purposes should be established to reduce HAI and AMR.	The panel recommends that facility-based HAI surveillance should be performed to guide IPC interventions and detect outbreaks, including AMR surveillance, with timely feedback of results to HCWs and stakeholders and through national networks.
MINIMUM REQUIREMENTS	**IPC surveillance and a monitoring technical group** • Establishment by the national IPC focal point of a technical group for HAI surveillance and IPC monitoring that: – is multidisciplinary; – develops a national strategic plan for HAI surveillance (with a focus on priority infections based on the local context) and IPC monitoring.	► **PRIMARY CARE** • HAI surveillance is not required as a minimum requirement at the primary facility level, but should follow national or sub-national plans, if available (for example, detection and reporting of outbreaks affecting the community is usually included in national plans). ► **SECONDARY CARE** • HAI surveillance should follow national or sub-national plans. ► **TERTIARY CARE** **functional HAI surveillance** • Active HAI surveillance should be conducted and include information on AMR: – enabling structures and supporting resources need to be in place (for examplem dependable laboratories, medical records, trained staff), directed by an appropriate method of surveillance; – the method of surveillance should be directed by the priorities/plans of the facility and/or country. • Timely and regular feedback needs to be provided to key stakeholders in order to lead to appropriate action, in particular to the hospital administration.

One key action in the WHO global action plan is to establish or strengthen national surveillance systems for HAI and related AMR, particularly by involving tertiary and secondary health care facilities in a national surveillance network. Most importantly, HAI and AMR surveillance were prioritized among the top core targets in the IPC monitoring framework through a Delphi study including IPC international experts and national focal points, followed by subsequent consultations with Member States prior to approval by the World Health Assembly. These core targets are:

1. increasing the proportion of countries with a national HAI and related AMR surveillance system, including for early warning to detect epidemic-and pandemic-prone pathogens causing HAIs to 30% by 2026, 50% by 2028, and over 80% by 2030;
2. increasing the proportion of tertiary/secondary health care facilities having a surveillance system for HAI and related AMR, including for early warning to detect epidemic- and pandemic-prone pathogens to 30% by 2026, 50% by 2028, and over 80% by 2030 *(3)*.

Fig. 1. Strategic direction 5 in the WHO global strategy on IPC *(3)*

Data for action

a. Establish and/or better utilize systems for regular data collection (including high-quality laboratory data) and feedback on IPC and WASH indicators (particularly for hand hygiene) and HAI surveillance (including for epidemic/pandemic-prone diseases and health and care workers' infections).

b. Ensure training and expertise for data collection, analysis, interpretation and quality control.

c. Ensure integration of IPC and HAI data into national health information and accreditation systems, and provide regular feedback on key IPC performance indicators to relevant audiences and stakeholders.

d. Establish mechanisms for accountability based on IPC and HAI data.

e. Use these data for action in a spirit of safety and quality improvement and not for punishment or penalties.

f. Develop, implement, measure, and regularly update locally tailored and actionable improvement plans.

Table 2. National indicators and global targets for HAI surveillance *(4)*

IPC global strategic direction no. 5 Data for action (HAI surveillance)			
Key action at national level	**Key players**	**National indicators**	**Global core target**
Establish and/or strengthen a national surveillance system for HAI and related AMR including for early warning the ability to detect epidemic-and pandemic-prone pathogens and for monitoring antimicrobial consumption. Ensure that tertiary/ secondary health care centres (at least referral centres) participate in national or international HAI and AMR surveillance networks.	Political and government and health care leaders; IPC and other focal points/leaders (ministry of health; national IPC committee; leaders at public health and other national institutes); educational institutions and scientific societies.	1. National strategic plan for surveillance of HAI and related AMR (with a focus on priority infections based on the local context) developed by a multidisciplinary technical group (by 2026) within the context of a broader surveillance system. 2. National/subnational surveillance system for HAI and related AMR (including for early warning the ability to detect epidemic- and pandemic-prone pathogens causing HAI) established and supported (including financially) by governmental and national/subnational authorities (by 2028). 3. Proportion of tertiary/secondary health care facilities participating in the national/subnational or international network for surveillance of HAI and related AMR, if existing. 4. Proportion of tertiary/secondary health care facilities having a surveillance system for HAI and related AMR including for early warning the ability to detect epidemic- and pandemic-prone pathogens.	Increase of the proportion of countries with a national surveillance system for HAI and related AMR to: 30% by 2026 50% by 2028 >80% by 2030.
Key action at facility level	**Key players**	**Facility indicators**	**National core target**
Make implementation plans and provide resources (human and financial) to achieve all WHO minimum requirements for HAI surveillance according to the facility level and to progressively achieve all requirements of core component 4 on HAI surveillance.	Local political, government and health care leaders; IPC and infectious diseases surveillance focal points/ leaders; senior managers including the director-general, medical and nursing directors.	Percentage of WHO minimum requirements for HAI surveillance met (only tertiary and secondary health care facilities).	Increase of proportion of tertiary/secondary health care facilities having a surveillance system for HAIs and related AMR to: 30% by 2026 50% by 2028 >80% by 2030.

Abbreviations: IPC, infection prevention and control; HAI, health care-associated infection(s); AMR, antimicrobial resistance.

4.3 WHO protocol for surgical site infection surveillance with a focus on health care settings with limited resources

Considering their importance as the most frequent type of HAI in LMICs, WHO has prioritized surgical site infections (SSI) since 2015 in order to promote awareness of the need to increase country capacity for their detection and prevention.

As part of an implementation package for SSI prevention *(5)*, a WHO protocol for SSI surveillance was issued for health professionals in charge of surveillance, with a specific focus on health care settings with limited resources. The protocol provides guidance on SSI case definitions, risk factors for SSIs, how to set up an SSI surveillance system, and practical and reproducible methods for data collection, analysis, interpretation and feedback, including data collection forms *(6)*.

4.4 OpenWHO online course on health care-associated infections surveillance

A comprehensive course on the principles and methods for HAI surveillance is available online and several parts of this handbook are based on the content of this course *(7)*.

5. Status of health care-associated infections surveillance systems in Member States

In 2010, only 16% of LMICs had established HAI surveillance at national or subnational level *(8)*. The WHO global report on IPC issued in 2022 highlighted that HAI surveillance remains one of the least implemented components of IPC programmes at both national and facility levels, particularly in LMICs *(9)*.

The 2019 global survey among acute health care facilities using the WHO IPC assessment framework (IPCAF) tool revealed significant disparities in HAI surveillance implementation between low- and high-income countries, with weighted median scores of 12.5/100 *versus* 85/100, respectively (*10)*. In the 2017–2018 global survey of IPC implementation at the national level, it was found that among countries with a dedicated budget for IPC, most allocated funds to HAI surveillance (19/23). Most countries with a national HAI surveillance system monitored at least one of the following types of HAI: catheter-associated urinary tract infection (CAUTI); ventilator-associated pneumonia (VAP); central line-associated bloodstream infection (CLABSI); or SSI *(11)*.

The 2021–2022 WHO global survey on IPC minimum requirements at the national level inquired about the existence of a national strategic plan for HAI surveillance. The majority of participating countries reported having such a plan (83%; [95% confidence interval, 75.8–90.3]), with no significant differences by income level. Additionally, nearly three-quarters of the countries reported having the necessary expertise and a multidisciplinary technical group for HAI surveillance at national level *(9)*. However, having a national strategic plan, expertise and a dedicated multidisciplinary technical group for HAI surveillance does not mean that an implemented and fully functioning system is yet in place.

6. Definition, epidemiology and burden of health care-associated infections

6.1 General definition of health care-associated infections

These infections can be acquired in any setting where health care is delivered, such as hospitals, outpatient clinics, long-term care facilities, rehabilitation, home care and other health care settings. HAI can affect any part of the body and include common infections such as bloodstream infections (BSI), urinary tract infections (UTI), SSI, and pneumonia. A general definition of HAI is an infection occurring in a patient during the process of care in a hospital or other health care setting, which was not present or incubating at the time of admission.

6.2 Surveillance definition of health care-associated infections

Surveillance definitions of HAI are standardized criteria used to consistently identify and report HAI for monitoring and comparison purposes. These definitions are crucial to ensure accurate and reliable data collection, which is essential for understanding the epidemiology of HAI, benchmarking infection rates, and guiding IPC strategies.

Surveillance HAI definitions typically include:

- **specific clinical criteria:** signs and symptoms that must be present to qualify as HAI;
- **microbiological and radiological evidence:** laboratory test results and radiological evidence that support the diagnosis of HAI;
- **timing:** A specified time frame in which the infection must develop in relation to health care exposure or a specific health care intervention. This time interval is usually at least 48 hours from admission to the health care facility or care delivery.

The use of standardized HAI surveillance case definitions ensures that data collected across different facilities and regions are comparable. This allows health care organizations to benchmark their performance with others, identify trends, and implement targeted interventions to reduce the incidence of HAI. Of note, benchmarking relies not only on standardized HAI case definitions and the use of overall (crude) HAI surveillance metrics without accounting or adjusting for potential confounders can result in misleading conclusions. Several factors need to be taken into consideration such as facility characteristics (size, type patient populations, etc.), patient demographics (age, gender, underlying conditions, etc.) and surveillance methodologies.

WHO has developed simplified HAI case definitions specifically adapted for use in low-resource settings, acknowledging that the application of international definitions (such as those of the United States Centers for Disease Control and Prevention [US CDC] *(12)* and the European Centre for Disease Prevention and Control [ECDC] *(13)* may not always be feasible due to limited laboratory and diagnostic capabilities. These definitions aim to provide a balance between accuracy and feasibility, thus facilitating a broader participation in HAI surveillance activities globally (see chapter 13 and Annex 1 for more details).

6.3 Epidemiology and burden of health care-associated infections

HAI pose a serious risk to patients and are among the most common complications occurring during health service delivery. They represent a significant problem for health care facilities and are associated with increased patient morbidity and mortality, prolonged hospital stay, and a substantial economic burden on health systems *(8, 14).* Indeed, the ECDC estimated that the burden of the six most frequent HAI was calculated to be twice the burden of 32 other infectious diseases all together in terms of disability and premature mortality *(15)*.

In 2010, out of every 100 patients in acute care hospitals, on average, seven patients in high-income countries and 15 patients in LMICs will acquire at least one HAI during their hospital stay *(8).* In intensive care units (ICUs), up to 30% of patients can be affected by HAI, with an incidence that can be two to 20 times higher in LMICs than in high-income countries, particularly among neonates. Approximately one in four (23.6%) of all hospital-treated sepsis cases are HAI and almost one half (48.7%) of all cases of sepsis with organ dysfunction treated in adult ICUs are estimated to be acquired in the hospital *(9)*.

Recent reviews and studies on the frequency of HAI reported that the pooled prevalence of HAI was estimated to be 12.9% in the WHO South-East Asia Region, 9.7% in the WHO Western Pacific Region, 12.5% in the WHO Eastern Mediterranean Region, and 27% in the WHO African Region, 9.6% in the WHO Region of the Americas, 3.2% in the United States of America (USA), and 7.9% in Canada *(16–18)*.

The global increase in AMR over the last decades has significantly exacerbated the problem as many common HAI are caused by multidrug-resistant organisms. The increased use of broad-spectrum antimicrobials and extended hospital stays among patients further contribute to the development and spread of AMR. It was estimated that 136 million cases of health care-associated, antibiotic-resistant infections occur worldwide every year. In Europe, it was estimated that 63·5% of cases of infections with antibiotic-resistant bacteria in 2015 were associated with health care *(14)*. These infections not only harm patients across health care systems in all countries worldwide, but can also spread to the community *(3, 19, 20)*. This has a consequence on global mortality as more than 5 million deaths worldwide were estimated to be associated with AMR in 2019 *(21)*.

Global estimates of HAI frequency are hindered by underreporting, poor data quality, and a lack of standardized methods and protocols, resulting in a scarcity of reliable data, particularly in LMICs. Additionally, cultural differences and historical or punitive measures for reporting HAI can further affect reporting behaviours and the accuracy of data. This data gap and the inability to monitor progress prevents effective advocacy for IPC resources.

7. Common types of health care-associated infections

This handbook focuses on the four most frequent and commonly reported types of HAI: BSI; SSI; UTI; and pneumonia. These types of infections are prevalent across health care settings and represent significant challenges for IPC efforts *(22)*. Each type poses unique risks and requires specific strategies for effective surveillance, prevention and management.

7.1 Bloodstream infections

BSI occur when microorganisms (bacteria, viruses, fungi, and protozoa) enter the bloodstream, potentially leading to severe complications like sepsis, organ dysfunction or septic shock. Clinical symptoms of BSI may include fever, chills and hypotension. These infections are often associated with the use of intravascular devices such as central lines (CLABSI) or peripheral cannulas. The risk increases with the frequent and unsafe insertion and handling of these devices, during surgical procedures or through the use of contaminated equipment.

BSI can also arise as secondary infections when pathogens spread from the primary site of infection (such as the lungs, urinary tract or surgical wound) into the bloodstream. Additional risk factors for BSI, especially those acquired in ICUs, include a high severity of illness at admission, prolonged ICU stay, immunosuppression, liver disease, and admission to a surgical ward *(23, 24)*.

ICU-acquired BSI occur in 5–7% of admissions, corresponding to an average of 6–10 episodes per 1000 patient-days. A large international study conducted across 45 countries in all WHO regions estimated an incidence density of 5.3 CLABSI per 1000 central line days in ICU patients *(25)*. In Africa, the prevalence of BSI ranges from 2.4% to 41.2%, with a median prevalence of 20% *(26)*.

7.2 Surgical site infections

SSI are among the most common complications following surgical procedures, whether in hospitalized patients or those undergoing surgery in outpatient services. They occur when bacteria enter through surgical incisions or are introduced during the postoperative phase, such as through dressing changes or other routes *(27)*. Clinical signs and symptoms of SSI vary, based on the infection type and severity, and can include redness, swelling, pain, tenderness and the drainage of pus or fluid from the incision site. They can be superficial infections involving the skin and subcutaneous tissue or more serious, involving deeper tissues, organs or implanted material *(28)*.

Risk factors for SSI can be categorized as either patient-related or procedure- related. Patient-related risk factors include underlying medical conditions, immunosuppression, advanced age, smoking and obesity. Procedure-related risk factors include the duration of surgical procedures, the quality of aseptic technique and practices used, inadequate sterilization, the use of foreign material (such as implants) and a prolonged preoperative stay *(28)*.

SSI pose significant threats to patient health, leading to high morbidity, discomfort, and extended hospital stays. On average, SSI increase hospital stay by 10 days *(29)* and can raise the cost of surgery by 300-400% *(30)*. SSI also contribute to higher rates of hospital readmission and negatively impact health outcomes *(31)*. A systematic review of 57 studies involving adult general surgical patients found a pooled 30-day cumulative incidence of SSI at 11% (95% confidence interval (CI), 10-13), meaning that 11 of 100 general surgical patients developed an infection within 30 days after surgery *(32)*. SSI were the most common HAIs and accounted for 41.6% of all HAIs (95% CI, 23.55–59.80) in African studies reviewed from 2010–2022 *(33)*.

7.3 Urinary tract infections

UTI is an infection that can affect any part of the urinary system, including the urethra, bladder, ureters, and kidney. While most UTI are caused by the bacterium *Escherichia coli,* other microorganisms such as *Klebsiella pneumoniae and Pseudomonas aeruginosa* can also be responsible. Clinical symptoms of UTI include frequent urination, a strong urge to urinate, a burning sensation during urination and pelvic pain. If left untreated, UTI can lead to serious complications such as sepsis or organ failure.

Several risk factors can increase the likelihood of developing UTI. Approximately 75% of health care-associated UTI are associated with the insertion of a urinary catheter, leading to CAUTI. Inadequate IPC practices such as improper catheter care, prolonged catheter use, and the use of non-sterile equipment contribute significantly to the risk of acquiring a UTI. Patient-related factors include female sex (due to shorter female urethra), advanced age, altered mental status, chronic diseases and immunosuppression *(34)*. A large international study in 45 countries across all WHO regions estimated an incidence density of 3.16 CAUTI per 1000 urinary catheter days in patients admitted to ICUs *(25)*.

7.4 Health care-acquired pneumonia

Respiratory tract infections are one of the most common HAI, particularly in critical care, and affect more than one-quarter of patients admitted to ICUs. HAP occurs when infectious agents such as bacteria, viruses or fungi enter the lungs, leading to infection.

In 2023, among the 22,806 HAI reported in EU/EEA countries, respiratory tract infections were the most frequent, accounting for 29.3% of the total, including pneumonia (19.0%), coronavirus disease (COVID-19) (7.0%), and other lower respiratory tract infections (3.3%).

In ICUs, mechanical ventilation (also known as VAP) is the most frequent HAI, impacting a high percent of critically ill patients *(35)*. In six ICUs in France, VAP affected 5–40% of patients receiving invasive mechanical ventilation for more than 2 days, with a significant variation depending on the ICU type and criteria used to identify VAP *(36)*. VAP is associated with substantial morbidity and mortality, with an estimated attributable mortality rate of around 10%. Mortality rates are higher among surgical patients and those with mid-range severity scores at admission *(37)*.

VAP rates in hospitals in the USA have been reported as low as 1–2.5 cases per 1000 ventilator-days, while an incidence density of 18.3 VAP episodes per 1000 ventilator days was found in nine European countries hospitals *(38)*. A systematic review of VAP among adults in Asia found that the pooled incidence density was high in lower- and upper-middle-income countries and lower in high income countries (18.5, 15.2 and 9.0 per 1000 ventilator-days, respectively) *(39)*.

A study across 45 countries in all WHO regions estimated an incidence density of 11.47 ventilator-associated events per 1000 mechanical ventilator-days in patients admitted to ICUs *(25)*.

8. Objectives of health care-associated infections surveillance

The ultimate goal of HAI surveillance systems is to improve the quality of health care, patient safety, patient outcomes, IPC decision-making, policy and research through the collection, analysis, and interpretation of critical data on HAI occurrence *(1, 40)*.

The primary objectives of HAI surveillance systems are to collect and analyse critical data on the occurrence of HAI. These systems serve several key purposes *(7, 19, 20)*:

- **describe the frequency of HAI:** identify the prevalence and incidence of HAI in health care facilities;
- **identify trends and high-risk populations:** detect trends in HAI occurrence and pinpoint populations and procedures at high risk;
- **characterize pathogens:** identify pathogens causing HAI and their antimicrobial susceptibility profiles;
- **inform IPC interventions:** provide critical information to plan and tailor effective IPC interventions and policies;
- **evaluate IPC impact:** assess the effectiveness of targeted IPC interventions over time;
- **support antimicrobial stewardship:** inform national and local antimicrobial stewardship strategies by providing data on HAI caused by antimicrobial-resistant organisms *(19)*;
- **detect clusters and outbreaks:** identify and respond to clusters and outbreaks of infections;
- **benchmarking:** compare infection rates to benchmarks to gauge performance and areas for improvement;
- **indicator of quality and safety:** use surveillance data as an indicator of quality of care and patient safety.

9. Principles of health care-associated infections surveillance systems

9.1 Principles for the national level

At the national level, HAI surveillance is a key component of the IPC programme implementation, as outlined in the WHO manuals on IPC core components and minimum requirements *(1, 2)*.

The following principles should guide the development and operation of a national HAI surveillance system.

- **Governance:** ministries of health must establish a clear governance structure for the national HAI surveillance system. This includes defining who is responsible for the design, management and coordination of the system, and assigning specific roles and responsibilities.
- **Resource allocation:** adequate resources, including financial and human resources, must be allocated to support the functioning and sustainability of the HAI surveillance system at all levels.
- **Integration with other surveillance programmes**: it is essential to establish linkages between HAI surveillance and other relevant surveillance programmes, particularly aligning HAI surveillance with AMR surveillance.

- **Monitoring and oversight**: the national IPC committee should be responsible for monitoring the implementation of the national HAI surveillance plan to ensure that it is carried out effectively across the country.
- **Subnational surveillance networks:** depending on the structure of the health care system, national entities should consider establishing subnational, regional, or district-level HAI surveillance networks to ensure comprehensive coverage and data collection.

9.2 Principles for the facility level

At the facility level, establishing and implementing an effective HAI surveillance system is crucial for improving patient outcomes and ensuring quality care. This is particularly important in secondary and tertiary care facilities, which play a key role in contributing to the national HAI surveillance system. The following principles should guide the establishment and operation of HAI surveillance systems at the facility level.

- **Governance:** the health care facility administration should establish a clear governance structure for HAI surveillance. This includes assigning a HAI surveillance lead (if different from the facility IPC team lead) as well as supporting team members, including defining roles and responsibilities.
- **Alignment with national policies:** health care facilities should develop their own HAI surveillance policies, plans and procedures that align with the national HAI surveillance plan. These should be tailored to the specific infections most relevant to the facility, based on the services provided and the population served.
- **Resource allocation:** the facility administration should allocate financial resources to support HAI surveillance activities and ensure that the necessary infrastructure, such as microbiology laboratories, is adequately equipped to support accurate HAI case definitions.
- **Integration with AMR surveillance:** tertiary health care facilities conducting HAI surveillance should ideally integrate their efforts with the facility's AMR surveillance system, if available.
- **Action plans:** facilities should develop and regularly update tailored prevention activities based on surveillance data, documented in a formal action plan aimed at continuous quality improvement.
- **Subnational/regional plans:** in countries with subnational HAI surveillance networks, health care facilities should align their surveillance efforts with the respective subnational plans.
- **Medical records:** the administration should also ensure that patient medical charts and records are thoroughly and accurately maintained to support effective HAI surveillance.
- **Primary health facility considerations:** while HAI surveillance is not required as a minimum standard at the primary health care facility level, these facilities should follow national or subnational plans if available, particularly in detecting and reporting community outbreaks.

10. Methods of health care-associated infections surveillance

The selection of the methods of HAI surveillance at national and facility levels depends on the surveillance capacities across different resource settings, regions and health care systems. Countries should identify the surveillance strategy and approach that meets their situation and local context. The choice of the type of surveillance relies on various factors related to the status and capabilities of the IPC programme at national and facility levels, the experience and level of training of the professionals that will be responsible for implementing the surveillance, the clinical, laboratory, radiology and data management services available, and the information technology (IT) available at the country and health care facility level. An important element is the capacity of the hospital microbiology laboratory and its ability to reliably diagnose infections and describe the antimicrobial susceptibility profile of identified pathogens. Additional investigations that are important include radiological investigations and other imaging to support the diagnosis of pneumonia or organ-space SSI *(41, 42)*.

10.1 Active versus passive surveillance

Active surveillance is the best option to identify and detect HAI. In active surveillance, data are specifically collected for the purpose of surveillance, usually prospectively, by trained personnel searching for infections according to HAI case definitions. Active surveillance can be resource-intensive, requiring trained professionals (IPC and/or surveillance teams) and time dedication. In addition, adequate and quality-assured microbiology laboratory and radiology services are critical to identifying infections in a systematic way.

Passive surveillance relies on data sources not specifically intended for surveillance and is often retrospective and not conducted by trained surveillance staff. However, although this method is less demanding than active surveillance and may be the only feasible method in settings that lack expertise in surveillance and resources, it is the least sensitive way to detect infections. Notably, it is associated with higher levels of underreporting as it relies on information provided from health care providers whose responsibilities are centred on patient care and who are less familiar with the application of HAI case definitions. Passive surveillance systems may not provide high quality data or timely information on changes in the risk of HAI *(43).*

10.2 Patient-based versus laboratory-based surveillance

Patient-based surveillance links the laboratory with clinical data and patient information. It estimates the frequency of HAI and assesses risk factors. This type of surveillance provides useful epidemiological data to be used for developing IPC prevention strategies. Patient-based surveillance requires visits to patient care areas and review of patient medical charts and records *(7)*.

A laboratory-based surveillance means that infection identification is based solely on positive laboratory findings from the patient's clinical specimens (blood, urine, swab, etc.), without a link to patient clinical records, results of other diagnostic tests (for example, X-ray or others), or patient characteristics *(7)*. This type of surveillance describes the pathogens and their resistance pattern detected by the hospital laboratory and can help identify the most frequently isolated pathogens in inpatients and the extent of AMR within the health care facility. Note that if the date of patient admission to the health care facility is not available in the laboratory data, it will be difficult to distinguish a community infection from a HAI. Lack of additional data within the laboratory, such as specimen collection source or clinical signs or symptoms, makes the use of laboratory-based surveillance limited for HAI surveillance.

10.3 Comprehensive versus targeted (focused) surveillance

Health care facility populations under surveillance can differ according to the specified national and facility level objectives of the HAI surveillance plan. Two approaches can be considered: (1) comprehensive or facility-wide surveillance where all patients are observed (that is, all patient populations under surveillance) versus (2) targeted or focused surveillance where selected wards, patients or types of HAI are observed (for example, specific patient populations or specific HAI are deemed particularly relevant to put under surveillance).

Comprehensive surveillance involves the collection of data across all or most wards and patient populations, including a wide range or all types of infections. This type of surveillance is more feasible for point prevalence surveys but may be labour intensive in the case of prospective surveillance.

Targeted or focused surveillance is particularly relevant for prospective longitudinal surveillance. It involves a more focused narrow-spectrum approach, concentrating on specific selected infections, patient populations at risk (that is, deemed "vulnerable"), or departments within the health care facility to enable to address specific challenges and risks. It allows for more efficient resource allocation and more focused IPC interventions. However, it can miss clusters or outbreaks in other patients (7).

Considerations for targeted/focused surveillance

1. **Prevalence and incidence:** there should be a focus on infections with the highest occurrence rates in the facility as they represent significant areas of concern.
2. **Severity and impact:** infections should be prioritized that lead to severe patient outcomes, such as high morbidity, mortality or prolonged hospital stays.
3. **Resource availability:** the availability of resources should be considered, including staff, time, and financial resources, to ensure the feasibility of sustained surveillance.
4. **Risk factors:** patient populations or units at higher risk for specific infections, such as ICUs, surgical wards or immunocompromised patients should be identified.
5. **Outbreak history:** areas with a history of outbreaks or clusters of infections as these may require more intensive monitoring should be considered.
6. **Regulatory requirements:** surveillance targets should be aligned with national or regional public health mandates and reporting requirements.
7. **Preventability:** infections that have well-established prevention strategies and interventions should be focused upon to maximize the impact of IPC measures.
8. **Diagnostic capabilities:** the facility should ensure that they have the necessary diagnostic tools and laboratory capacity to accurately identify and monitor the targeted infections.
9. **Stakeholder priorities:** engagement with health care providers, IPC teams and administrators is important to incorporate their insights and address their specific concerns and priorities.
10. **Benchmarking:** infections that are commonly monitored in other facilities or regions should be considered, thus allowing for comparison and benchmarking against broader data sets.

Examples of targeted/focused HAI surveillance

- Device-associated infections in ICUs
- SSI related to specific surgical procedures
- Infections in neonatal ICUs
- Surveillance in high-risk patient populations, for example, immunocompromised and cancer patients or transplant recipients.

10.4 Prevalence versus incidence

10.4.1 Prevalence of health care-associated infections

The prevalence of HAI refers to the proportion of the patient population within a health care facility who have acquired an infection while receiving medical care. It is typically expressed as a percentage (proportion). Prevalence surveys of HAI estimate active infections in a health care facility only at the time they are conducted, for example, either on a single day (*point prevalence*) or over a specified number of days (*period prevalence*) (Table 3). They can also be used to target specific areas or wards in the health facility where infection rates are known or suspected to be high. Data from each patient are collected only once during the time of the survey. Prevalence surveys can be repeated at regular intervals to show change. They may be quicker and less expensive than incidence *(7).*

a) Advantages of health care-associated infections prevalence surveys

1. Prevalence surveys can be used on a national level where they provide accurate and reproducible data. They are also an appropriate method to collect data on all (or multiple) types of HAI at facility-wide level.
2. Quantification of the infection: prevalence surveys provide a quantitative measure of the extent of HAI within a specific country, if a random sample of health care facilities is included in the surveys.
3. Qualitative measure: prevalence surveys provide a qualitative measure of the extent of HAI within a specific health care facility, helping to assess the magnitude of the problem.
4. Time and financial implications: a rapid, relatively low-cost way to estimate the magnitude of HAI at a single point in time at a health care facility or at national level.
5. Benchmarking and comparison: prevalence data can allow for benchmarking and the comparison of proportions of infections across different health care facilities or time periods and help to identify areas for IPC quality improvement.
6. Identifying trends: regular prevalence surveys enable to track trends of infection over time and help health care providers and policy-makers to implement targeted interventions and evaluate the impact of IPC.
7. Implications for surveillance: through prevalence data, targets for additional surveillance activities may be identified.
8. Quality improvement and IPC implications: data obtained from prevalence surveys can guide quality improvement initiatives, fostering a culture of continuous improvement in IPC practices. By understanding the prevalence of HAI, health care facilities can identify priority areas for IPC and allocate resources more effectively.

b) Limitations of health care-associated infections prevalence surveys

While prevalence surveys of HAI offer valuable insights, they also have some limitations. Below are listed some examples of limitations.

1. The **accuracy** of the infection estimate might be compromised by the seasonality of the infection. For example, a prevalence survey for HAI respiratory infections during the winter months for health care-acquired respiratory infections might suggest an increased risk, given the seasonal pattern of such occurrences.
2. **Limited temporal resolution**: prevalence surveys provide only a snapshot of infections at a specific point in time, making it challenging to capture dynamic changes and trends over

shorter time intervals. On average, patients with HAI may have longer hospital stays and a higher likelihood of being observed in a prevalence survey, thus potentially overestimating the prevalence of HAI at that point in time.

3. **Limited utility** in identifying outbreaks.

Table 3 presents prevalence calculation methods.

Table 3. Description and calculation of key prevalence measures

Measure of occurrence	Description	Calculation/notes	Examples
Point prevalence	Proportion of patients with a HAI at a specific point in time, expressed as a percentage.	$\frac{\text{Number of patients with at least one HAI on the survey day}}{\text{Total number of patients surveyed}} \times 100$	On a single day, 25 of 250 patients in the hospital have an active HAI, resulting in a point prevalence of 10%.
Period prevalence	Proportion of patients with a HAI over a specified period (for example, a week or a month).	$\frac{\text{Number of patients with at least one HAI during the period}}{\text{Total number of patients surveyed during the period}} \times 100$	Over a two-week period, 15 of 150 surgical patients developed a SSI post-operation, leading to a period prevalence of 10%.
Device-associated prevalence	Proportion of patients with a device-related infection (for example, CAUTI) at the time of the survey.	$\frac{\text{Number of patients with a device-associated HAI}}{\text{Total number of patients with that device}} \times 100$	During the survey, 5 of 50 patients with a urinary catheter had a CAUTI, resulting in a device-associated prevalence of 10%.
Ward-specific prevalence	Proportion of patients with HAI within specific wards or units (for example, ICU, surgical ward) at the time of the survey.	$\frac{\text{Number of patients with at least one HAI in a specific ward}}{\text{Total number of patients in that ward}} \times 100$	In the ICU, 8 of 40 patients have a HAI, giving a ward-specific prevalence of 20%.

Abbreviations: HAI, health care-associated infection; SSI, surgical site infection; CAUTI, catheter-associated urinary tract infection.

10.4.2 Incidence of health care-associated infections

The incidence of HAI refers to the rate or frequency of new infections that occur within a health care facility over a defined period of time. Conducting surveillance using incidence is prospective, more reliable, but resource intensive, as it requires well-trained and dedicated teams to systematically screen entire patient charts and perform data collection and interpretation. Case finding by a well-trained surveillance team increases HAI detection. Incidence is the best way to track trends of HAI over time and to study specific types of infection which require follow-up with patients at risk (Table 4) *(7)*.

a) Advantages of health care-associated infections incidence surveys

1. Trend analysis: tracks infection rates over time, identifying seasonal variations and long-term changes.
2. Real-time monitoring: provides up-to-date information on infection risks.
3. Impact evaluation: assesses the effectiveness of IPC interventions by comparing pre- and post-intervention infection rates.
4. Resource allocation: informs better planning and allocation of resources.
5. Quality improvement: supports continuous quality improvement in patient safety and infection control.
6. Outbreak detection: monitors incidence to detect and respond to outbreaks promptly.
7. Risk factor identification: helps to identify risk factors associated with HAI for targeted prevention strategies.
8. Benchmarking: enables comparisons with historical data and other institutions, supporting best practices.
9. Precision: offers more precise infection estimates at the hospital level compared to prevalence surveys.

b) Limitations of health care-associated infections incidence surveys

Resource intensity: requires significant resources, including trained personnel, time and funding.

Focused surveillance: often limited to high-risk areas, which may not reflect the full infection picture in the health care facility.

Table 4 presents incidence calculation methods.

Potential sources of bias

1. **Accuracy of microbiology diagnostics**: in low-resource settings, the limited capacity (both in terms of availability and quality control) of microbiology laboratories and limited expertise in results' interpretation can affect the accuracy of point prevalence findings.
2. **Low utilization of diagnostics:** in low-resource settings, the cost of diagnostics often falls on patients and thus they are often underused to limit out-of-pocket expenses.
3. **Interrater reliability:** the degree of consistency and agreement in using criteria for HAI diagnosis among data collectors can infer bias and influence data comparability among different facilities or countries.
4. **Underreporting:** underreporting is a significant source of bias and there are several reasons for this, which are discussed in other parts of this document.
5. **Detection bias**: more severe or clinically evident infections are more likely to be reported than milder cases. This can lead to an overestimation of the severity of HAI and an underestimation of their true incidence.

Table 5 presents the key differences between the prevalence and incidence of HAI.

Table 4. Description and calculation of key incidence measures

Incidence rate	
Description	A general term used to express the probability of a HAI occurring within a population over a specified time period.
Calculation/ notes	**Note:** Encompasses both incidence proportion and incidence density as specific measures.
Incidence proportion (also known as 'cumulative incidence')	
Description	Measures the proportion of patients who develop a HAI within a defined surveillance period.
Calculation	$\frac{\text{Number of patients who developed a HAI}}{\text{Total number of patients admitted}}$ **Note:** To express the result as a whole number, multiply the proportion by a constant. For proportions, this constant is often 100, which converts the proportion into a percentage.
Example	We want to calculate the incidence proportion of HAI in a surgical ward of a hospital over a 1 month period: • surveillance period: January 1 to January 31: • total number of patients admitted: 200; • number of patients who developed a HAI: 10. **Incidence proportion =** 10/200 = 0.05 x 100 = 5% Incidence proportion is 5%. This means that 5% of patients admitted to the surgical ward during the surveillance period developed a HAI.
Incidence density	
Description	Measure of the frequency with which new cases of HAI occur in a population over a specified period, considering the time each patient is at risk.
Calculation	$\frac{\text{Number of patients who developed a HAI}}{\text{Total patient-days}}$ **Note:** To express the result as a whole number, multiply the proportion by a constant.
Example	We want to calculate the incidence density of HAI in an ICU of a hospital over a 1 month period: • **surveillance period**: January 1 to January 31; • **total number of patients admitted**: 100; • **number of patients who developed a HAI**: 5; • **total patient-days**: 1500 (sum of each patient's length of stay in days). **Incidence density =** 5/1500 = 0.0033 **To express the incidence density per 1000 patient-days:** 5/1500 = 0.0033 x 1000 = 3.3 Incidence density is 3.3 HAI per 1000 patient-days. This means that for every 1000 days of patient care in the ICU, there were 3.3 infections.

Table 4 (continued). Description and calculation of key incidence measures

Device-specific incidence density	
Description	Measure of the frequency of HAI among patients with a specific device in place, considering the total number of days the device was used.
Calculation	$\frac{\text{Number of patients with a device who developed a HAI}}{\text{Total device-days}}$ **Note:** To express the result as a whole number, multiply the proportion by a constant.
Example	We want to calculate the device-specific incidence density of CAUTI in a hospital ward over a 1 month period: • **surveillance period**: January 1 to January 31; • **total number of patients with a catheter**: 50; • **number of patients who developed a CAUTI**: 8; • **total catheter-days:** 600 (sum of each patient's days with a catheter in place). **Device-specific incidence density =** 8/600 = 0.0133 **To express the device-specific density per 1000 device-days:** 0.0133 x 1000 = 13.3 Device-specific incidence density is 13.3 CAUTI per 1000 catheter-days. This means that for every 1000 days of catheter use, there were 13.3 new cases of CAUTI.
Other epidemiological measures: Device utilization ratio	
Description	Measures the proportion of patients who have a specific device in place during a surveillance period.
Calculation	$\frac{\text{Total number of device-days}}{\text{Total number of patient-days}}$
Example	we want to calculate the device utilization ratio for urinary catheters in a medical ward over a 1 month period: • **surveillance period:** January 1 to January 31; • **total number of patient-days:** 1000 (sum of each patient's days in the ward); • **total number of device-days for urinary catheters:** 400 (sum of each patient's days with a urinary catheter in place). **Device utilization ratio** = 400/1000=0.4 ×100=40% Device utilization ratio is 40%. This means that, on average, 40% of patients had a urinary catheter in place during the surveillance period.

Abbreviations: HAI, health care-associated infection; ICU, intensive care unit; CAUTI, catheter-associated urinary tract infection(s).

Table 5. Key differences between the prevalence and incidence of HAI

Aspect	Point prevalence	Incidence
Definition	Proportion of patients with active HAI at a specific point in time expressed as a percentage.	Rate or ratio of new HAI occurring over a specified period of time.
Timeframe	Snapshot at a specific time point.	Cumulative over a specific period of time.
Measurement	Percentage or proportion of patients with HAI.	Rate per unit of population or patient exposure days.
Monitoring frequency	Often periodic may be annual or biannual.	Continuous or periodic surveillance.
Purpose/focus	Describes the magnitude of infections at a given time.	Emphasizes the rate of new infections over time and their dynamics reflecting their occurrence.
Limitations	• Does not capture the dynamics of infections. • Limited utility for outbreak detection. • Dependency on diagnostic practices.	• Resource intensive. • Selection bias in the case of limited populations selected. • Dependency of diagnostic practices.

Abbreviation: HAI, health-care associated infection.

11. Essential elements and best practices of health care-associated infections surveillance

This chapter outlines the six essential elements of HAI surveillance, which are similar to public health surveillance programmes for infectious diseases. These are: surveillance planning; data collection; analysis; interpretation; communication; and evaluation (Fig. 2).

Each element is explored in detail, providing a comprehensive background and narrative for both national- and facility-level perspectives. Additionally, we present best practices to guide the implementation and optimization of HAI surveillance systems to ensure that they are effective, sustainable and adaptable to various health care settings. The best practices for each element are presented first for the national level, followed by the facility level, to ensure linkages across the two levels of health care systems.

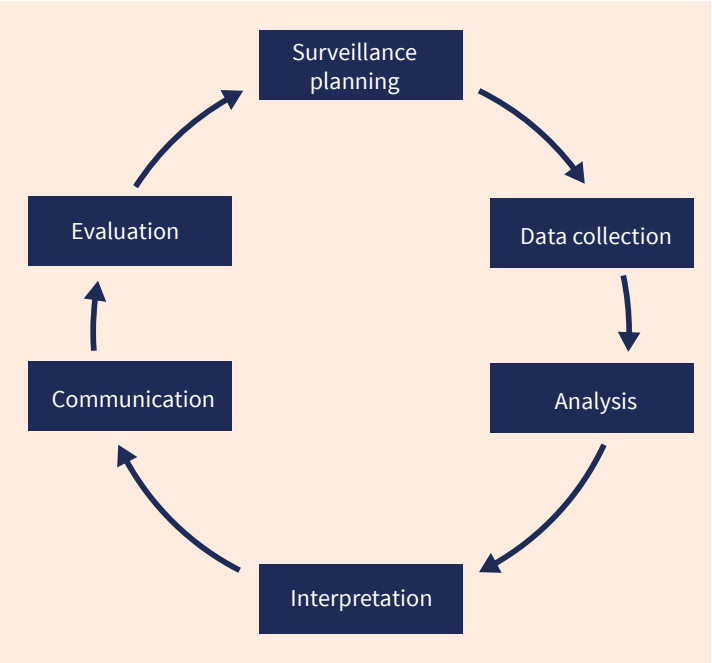


Fig. 2. Essential elements of HAI surveillance.

11.1 Health care-associated infections surveillance planning

11.1.1 Background: national level

Effective HAI surveillance begins with comprehensive planning. Surveillance planning involves development of a written national HAI surveillance plan, which is the foundation of any national HAI surveillance system. The plan should include goals, specific objectives, HAI surveillance governance, approaches for data collection, data analysis, reporting mechanisms, outcomes of surveillance and various methods to enable tailoring of preventive measures to reduce HAI based on surveillance results. The design of the national HAI surveillance system should be based on understanding the structure of the health care facilities and their existing capacities to identify the scope of surveillance, including which health care facilities to include in the HAI surveillance, geographical coverage, variation in the status of the IPC programme, including IPC staff and their training level, patient population of interest, capacities of the microbiology laboratories, prevalent infections, and preparedness to respond to infectious disease emergencies. The plan should be adaptable to different levels of health care and flexible to accommodate future modifications.

11.1.2 Background: facility level

Health care facilities eligible to conduct HAI surveillance should develop a HAI surveillance plan in alignment with the national one if available, while considering the specific circumstances within the facility. Rather than instituting a ‘‘one size fits all’’ approach to surveillance, facilities should tailor their surveillance system to focus on the available health facility services, patient population characteristics, the common medical procedures performed, the most likely types of infections, IPC programme capacities, IPC personnel within

the facility, and the microbiology laboratory capacities. Health care facilities are recommended to use the WHO IPC minimum requirements or assessment framework (IPCAF) tools to identify the baseline level of implementation of the HAI surveillance system, including the scoring level, and to use the tools for future measurement of the progress of implementation *(44–47)*.

11.1.3 Best practices: national level

Assigning who is responsible for HAI surveillance

- Ministries of health or alternative responsible national authorities should define a national governance structure for the design, management, supervision, coordination, monitoring and evaluation of the national HAI surveillance system in the context of the national IPC programme. The governance should include specific structures with detailed responsibilities, for example, who is responsible for the design, implementation, and monitoring of the HAI surveillance system, as well as clear roles and responsibilities for each structure.
- The national HAI surveillance system ***lead*** should be specified if different from the national IPC programme lead/focal point and should have sufficient expertise, experience and time to manage and coordinate the national HAI surveillance system. The HAI surveillance lead should be supported by a HAI surveillance ***team*** based on the anticipated workload.
- The national HAI surveillance lead/team, in collaboration with the national IPC programme lead (if different), have the responsibility to convene the ***technical multidisciplinary HAI surveillance group***. This group is assigned to develop a written national HAI strategic surveillance plan, participate in the development of a standardized national HAI surveillance protocol for data collection, develop a HAI surveillance training programme, and participate in the monitoring and evaluation of the national HAI surveillance system.
- The technical multidisciplinary HAI surveillance group should include all needed expertise, for example, health care epidemiologists, microbiologists, public health professionals, IPC and infectious disease specialists, statisticians, data managers and IT experts *(2)*.
- Monitoring of the implementation of the national HAI surveillance plan should be the responsibility of the national IPC committee, which is part of the national IPC programme structure and different from the technical multidisciplinary HAI surveillance group.
- If national capacities exist on HAI surveillance, the national HAI surveillance lead/team supported by the technical multidisciplinary HAI surveillance group and other authorities should set up subnational/regional/district HAI surveillance networks based on the structure of their health care system. This would imply that subnational/regional "technical multidisciplinary HAI surveillance group(s)" also coordinate the subnational HAI surveillance networks, including developing/agreeing on a subnational version of the HAI surveillance protocol (possibly integrated in existing surveillance systems if needed, or adopting an external protocol), providing technical assistance to participating hospitals, collecting data from hospitals, conducting data validation and analysis, providing timely (confidential) feedback of hospital results compared to network results, providing software, as well as organizing national or subnational training courses and feedback meetings, including the writing and publication of regular subnational reports.

Defining the goal and objectives of the HAI surveillance plan

- The national HAI surveillance plan should include clearly defined goals, for example, to enhance patient safety and improve health care quality.
- The plan should include a set of specific, measurable, achievable, relevant and time-bound (SMART) objectives that might include: reducing the incidence of specific HAI by a certain percentage within a set timeframe; improving the detection and response time to outbreaks or clusters of infection; describing the most frequent HAI, including those caused by AMR; and evaluating the impact of IPC interventions over time *(7, 20)*.

- Stakeholders should be engaged when defining the goals and objectives.
- The plan should include all essential components of surveillance: data collection; analysis; interpretation; communication/feedback; and evaluation and monitoring.

Examples of a national-level goal and objective

Goal: enhance national HAI surveillance to improve data quality and timeliness.

Objective: achieve 90% reporting compliance by health care facilities for monthly HAI surveillance data within three years.

Allocating resources

At the national level, it is critical for the HAI surveillance programme to have the necessary financial, human and technological resources to operate effectively. This involves budgeting, securing funding, and providing support to health care facilities. The following are the most important actions to be considered:

- create a detailed comprehensive budget that outlines the financial requirements for the national HAI surveillance system, including costs for personnel, training, data collection tools, and IT infrastructure;
- include provisions for emergency funds to address unexpected needs or outbreaks;
- secure funding from government sources, international organizations and other stakeholders to support the surveillance programme;
- establish partnerships with non-governmental organizations, academic institutions and private sectors to leverage additional resources;
- allocate human resources to ensure that the national HAI surveillance team is adequately staffed with multidisciplinary experts, including epidemiologists, IPC specialists, data analysts and IT professionals;
- provide ongoing training and professional development opportunities to maintain a skilled workforce;
- invest in technology and Infrastructure for the development and maintenance of electronic data management systems to facilitate data collection, storage and analysis;
- ensure that health care facilities have access to necessary technologies, such as computers and secure internet connections;
- provide technical and financial support to health care facilities to implement and sustain HAI surveillance activities;
- distribute standardized data collection tools and provide training on their use.

Defining methods of surveillance

- At the national level, defining methods of surveillance involves setting clear and standardized approaches and strategies to ensure consistency and comparability of HAI surveillance data across all participating health care facilities. This includes selecting specific surveillance methodologies such as active versus passive, patient-based versus laboratory-based, comprehensive versus targeted, and prevalence versus incidence.
- The national HAI surveillance lead/team should offer training programmes to health care facility staff on surveillance methods and protocols.

Identifying the types of infections to be assessed

The types of infections suggested in the national HAI strategic plan could be based on the services and structure of the health care facilities, accreditation requirements, expected frequency of HAI within specific

types of health facilities, preventability of infection, and impact of the infection (severity, case fatality and excess costs). Surveillance of some specific HAI can be identified as mandatory, if required.

Agreeing on standardized HAI case definitions

- The HAI surveillance strategic plan should include standardized HAI surveillance case definitions for all infections monitored. Once these definitions are established, they must be carefully and consistently followed to ensure meaningful data.
- Through international expert consensus, WHO has developed, tested, and validated a set of HAI case definitions specifically adapted for feasibility in limited resource settings (see Annex 1). The use of these definitions will promote a more meaningful interpretation and comparison of results and allow a more effective utilization of available resources designed to support implementation of these standardized definitions.

Selecting health care facilities to conduct surveillance

- The national HAI surveillance plan should include a strategic approach for the selection of health care facilities for HAI surveillance in order to build a robust surveillance network and ensure that the data collected is comprehensive, representative and actionable.
- Facilities selected should include a diverse representation to capture a broad range of data and develop criteria that consider various factors such as facility type, geographic distribution, and readiness to participate in surveillance activities.
- The readiness and capability of facilities to participate in HAI surveillance should be evaluated, including their data collection and reporting infrastructure. If needed, a baseline assessment should be conducted to understand their capacities (for example, IPC programme capacities, human resources, laboratory and other diagnostic capacities).
- The focus should be on facilities with high-risk populations or procedures, such as tertiary hospitals, surgical centres and ICUs, where HAI are more likely to occur.
- Facilities with a history of higher HAI rates or those in underserved areas should be included to address potential hotspots.

Determining the time period for HAI surveillance

- Identifying the HAI surveillance time period depends on factors such as the methods used for surveillance, type of infections, facility characteristics, and IPC programme capacities. Typically, HAI incidence is ongoing, but specific periods may be defined based on the capacities of the IPC programme within facilities. In high-resource countries, incidence surveys of specific types of HAI continue without interruption.
- When conducting prevalence surveys at health care facilities, the periodicity can vary. For example, common intervals include annually, or every two to five years.

Promoting collaboration

The national HAI surveillance lead/team should facilitate exchanges between facilities, foster a “surveillance culture and community”, and organize regular national or subnational meetings of surveillance networks involving local staff dedicated to HAI surveillance for training purposes and to exchange experiences.

11.1.4 Best practices: facility level

Assigning who is responsible for HAI surveillance

The hospital administration should define who is responsible for the design of the facility-level HAI surveillance plan, as well as who will be responsible for its implementation. Preferably, the hospital IPC team should be responsible for HAI surveillance activities. However, in some facilities, the IPC team needs support from additional staff or experts to design the facility HAI surveillance plan in alignment with the national HAI surveillance plan. Implementation of the plan should be the responsibility of the facility IPC team and/or supported by additional staff where the team could be named as the 'HAI surveillance team'. Members supporting HAI surveillance could be laboratory staff, clinicians, head nurses or others. The size of the HAI surveillance team should be aligned with the expected workload.

Defining the goal and objectives of the HAI surveillance plan

- Each facility should ensure that their goals and objectives are in line with the national HAI surveillance plan, realistic, and can be achieved with available resources.
- Facilities should customize goals and objectives based on local circumstances, such as the patient population and health care services provided. For example, a facility with a high number of surgical procedures might focus on reducing SSI.
- The HAI surveillance team should involve the IPC team (if different) and other relevant staff in the goal-setting process to ensure buy-in and practical input.

Examples of a facility-level goal and objective

Goal: improve the accuracy and completeness of HAI surveillance data in the surgical ward.

Objective: achieve 100% compliance with standardized HAI case definitions and data reporting protocols within one year, ensuring that all SSI are accurately recorded and reported.

Allocating adequate resources

- The hospital administration should allocate financial resources for the ongoing support of HAI surveillance efforts. This involves development of a facility budget that includes costs for surveillance personnel, training, and necessary tools, and IT technologies and infrastructure.
- Allocate funds for ongoing training and professional development to ensure staff are up-to-date with the latest surveillance methods and practices.
- The facility should invest in data collection tools, especially electronic health records or digital applications, computers, and secure internet connections.
- The facility should allocate resources for the maintenance and upgrade of the IT infrastructure to support data collection, storage and analysis.
- Ensure regular audits and updates to maintain system integrity and security.

Defining methods of surveillance

- Health care facilities should align with the methodology of HAI surveillance recommended by the national level.
- Facility HAI surveillance teams should conduct training sessions for IPC team members (if different), clinical staff and data collectors on the chosen surveillance methods to ensure that they are appropriately implemented.

Identifying the types of infections to be assessed

In the facility level HAI surveillance plan, health care facilities can decide on the priority infections to be included under surveillance if they cannot monitor all types of infections. The priority HAI selected should be among the types of infections identified by the national level.

Agreeing on standardized HAI case definitions

All facilities participating in the national HAI surveillance system should adhere to the standardized national HAI case definitions without changes for the infections to be assessed.

Determining the time period for HAI surveillance

The facilities should follow the recommendations in the national HAI strategic plan.

Promoting collaboration

The facility administration should encourage collaboration between the facility IPC/HAI surveillance teams and the health care staff within the facility through regular meetings to discuss, agree, improve and utilize the facility-level HAI surveillance system to reduce HAI.

11.2 Data collection

11.2.1 Background: national level

At the national level, establishing national data collection systems for HAI surveillance, including standardized data collection protocols and tools, is essential to support health care facilities in data collection and data entry and to receive national and subnational HAI data. These systems gather and aggregate standardized information from health care facilities across the country to create a comprehensive, reliable and actionable national HAI data set and to ensure consistency and reliability across health care facilities. It is preferable to use IT to establish these data collection systems.

11.2.2 Background: facility level

At the facility level, adhering to national data collection protocol ensures that the data collected is accurate, reliable and contributes to the overall national HAI surveillance system.

11.2.3 Best practices: national level

Developing standardized data collection protocols and tools

- The national HAI surveillance lead/team should develop national standardized data collection protocols including questionnaires or tools for data collection for use by health care facilities including the minimum set of data to be collected, standardized HAI case definitions, sources of surveillance data collection, mechanisms of HAI surveillance data reporting to the subnational and national levels, data quality indicators (accuracy, completeness, reliability), and the ethics of data collection.
- Examples of data collection tools include those used at the health care facility level, which gather information on facility characteristics (such as the number of beds, annual patient admissions, and discharges). Additionally, patient data collection tools capture demographic details of patients enrolled in surveillance, while infection data collection tools provide information based on the basic criteria and elements for defining infections according to HAI surveillance case definitions.

Identifying those responsible for HAI surveillance data collection

The national HAI lead/team should provide suggestions and criteria to identify the lead or team responsible for HAI surveillance data collection at facility levels according to their IPC programme capacities.

Identifying sources of surveillance data

- The national HAI surveillance team should provide guidance to health care facilities to identify the appropriate sources of HAI surveillance data and include these sources in the national standardized protocols.
- Examples of sources of surveillance data are patient medical charts, laboratory reports, nursing notes, physician reports, ward round summaries.

Establishing a reporting mechanism and structure for reporting HAI surveillance data

- Within the standardized protocols for data collection, the national HAI surveillance lead/team should include guidance on mechanisms for reporting HAI surveillance data from health care facilities to the national level, including the frequency and methods for HAI surveillance data submission.
- The national HAI surveillance lead/team should develop a system for timely reporting including the necessary infrastructure, such as IT systems and data management platforms to support data storage at the national level.
- The national HAI surveillance lead/team should specify the regulatory requirements or mandates for health care facilities to report HAI data to the national surveillance system.
- The national HAI surveillance lead/team should monitor the compliance with data reporting from the facility to the national level.

Ensuring data quality

- The national HAI surveillance lead/team should develop measures and indicators to ensure the quality of reported HAI surveillance data, for example, completeness, consistency, accuracy and the reliability of collected data.
- Instructions could be given to health care facilities on how to check the quality of HAI surveillance data before submission to the national level.
- Examples of quality indicators include:

    - completeness: the proportion of required data fields that are fully and accurately filled out, for example, ensuring that all patient demographic information, infection details, and outcome data are complete for every reported case;
    - consistency in data reporting: the uniformity of data reporting across different facilities and over time, for example, ensuring that the same case definitions are applied uniformly across different reporting periods and facilities so the data remains consistent over time;
    - accuracy of data reflecting the true status of infection or other variables: validation studies can check if the data reported match the data through independent auditing.

Developing a centralized database to aggregate and manage HAI surveillance data received from health care facilities for national data analysis

The national HAI surveillance lead/team should design a system to integrate HAI surveillance data reported from various health care facilities into one national HAI surveillance database. This could be done either manually or through the use of IT.

Providing continuous training and education in HAI surveillance data collection protocols and procedures

- The national HAI surveillance lead/team in collaboration with the national HAI multidisciplinary group should develop a national HAI training programme.
- The national HAI surveillance lead/team should train the health care facility surveillance leads/teams on all aspects and methods of the HAI surveillance system to ensure consistency and standardization in data collection. Examples are training on methods and sources of data collection, improving the data quality of HAI surveillance, as well as data reporting of HAI surveillance data locally and from the facility to the national level.

Ensuring compliance with relevant laws and ethical standards for data collection and use involves several key aspects

- The national IPC lead/focal point in collaboration with the national HAI surveillance lead/team should assure that the methodology of data collection does not violate national data protection laws.
- Laws and regulations governing health care data collection (if applicable) should be adhered to and ethical standards should be applied for data collection by protecting patient privacy and confidentiality.

11.2.4 Best practices: facility level

Using standardized data collection protocols and tools

- Health care facilities conducting HAI surveillance should implement the national data collection protocols and tools.
- If national tools do not exist, they should adopt international standardized ones to develop their specific data collection systems.
- Health care facilities should work on improving hospital records and documentation through better IT systems and strengthened laboratory capacities, especially in countries with limited resources.
- Facilities should adhere to the national HAI standardized case definitions outlined in the national HAI surveillance plan where available (or consider other standard best practices).
- Facilities should follow regular reporting cycles established by national entities, submitting HAI data through secure electronic systems or standardized reporting platforms at specified intervals.

Identifying those responsible for HAI surveillance data collection

Health care facilities should assign the facility team responsible for HAI surveillance data collection as described in section 8.2. This may be the facility IPC team and/or additional health care staff to provide support in the data collection process.

Identifying sources of surveillance data

- Health care facilities should use the protocols for data collection developed by the national team regarding sources of HAI surveillance data and should utilize all available data sources for data collection (patient medical charts, nursing and physician notes, laboratory, and other investigations) for diagnosing HAI.
- If data are not complete in the medical charts, they should improve and maintain information on patient, clinical, and laboratory data in the patient medical charts and other logbooks to improve the HAI surveillance system.
- Health care facilities with computerized health information systems may be able to extract the surveillance information electronically.

Establishing a reporting mechanism and structure for reporting HAI surveillance data

- Health care facilities should adopt the national data reporting system and establish a mechanism within the facility for reporting surveillance data to the national HAI surveillance lead/team in a timely manner.
- Health care facilities should develop an internal reporting mechanism to share HAI surveillance results within the facility with adequate interpretation and considerations for improvement.

Ensuring data quality

- Health care facilities should implement measures to ensure the quality of HAI surveillance data regarding accuracy, completeness and the reliability of collected data.
- Those in charge of HAI surveillance should check the most frequently missing types of data and enhance efforts to ensure completeness.
- Audits could be conducted to ensure all data items are collected and that the data set is complete.
- The timeliness of case documentation should be assessed by calculating the time from onset of infection(s) to the time when data are entered into the surveillance database *(7)*.

Reporting HAI surveillance data to the national level

Each health care facility is responsible for providing the data in a way that is consistent with the database structure developed by the national level.

Providing continuous training and education in HAI surveillance data collection protocols and procedures

Facility administrators should ensure that their facility HAI surveillance lead/team responsible for HAI surveillance are well trained at the national level.

11.3 Data analysis of health care-associated infections surveillance data

11.3.1 Background: national level

Correct analysis of HAI surveillance data is essential for producing reliable results and understanding infection trends, identifying risk factors, and informing targeted IPC interventions. At the national level, HAI data analysis provides a broad national epidemiological perspective for health care systems to better understand the overall landscape of HAI, thus helping to identify infection trends, prioritize IPC interventions and formulate evidence-based IPC policies. Additionally, the data will help in resource distribution for health care facilities.

11.3.2 Background: facility level

Health care facilities engaged in HAI surveillance also need to analyse their HAI data on regular basis to understand local infection patterns, assess the impact of IPC interventions, and respond to emerging threats. Ideally, the analysis plan should be harmonized across facilities within the national or subnational HAI surveillance programmes, according to guidance provided by the national team. However, the level and details of analysis may vary according to the facility's capacity and HAI surveillance system objectives, ranging from simple methods to more advanced techniques.

11.3.3 Best practices: national level

Regularity of data analysis

The national HAI lead/team should analyse the HAI data submitted by health care facilities on a regular basis, at least once annually, to provide broad national epidemiological perspectives for HAI.

Identification of national HAI indicators and development of analytical methods

- The national HAI lead/team should establish standardized analytical methods for examining HAI data, ensuring consistency and comparability across health care facilities.
- Key HAI indicators, such as infection rates, types of infections, and AMR patterns should be identified.
- Aggregated national and/or subnational HAI data of infection (prevalence or incidence) should be calculated.
- National trends and risk factor identification should be monitored.
- Estimates of HAI infections could be stratified by health care facility characteristics (type of care, type of facility, types of services).
- HAI surveillance data should be described in relation to patient demographics such as age, gender and underlying health conditions.
- Comparing national HAI data with international benchmarks can only be done if the same surveillance methods and case definitions are used.

Training of data analysts

The national HAI lead/team in collaboration with experts should provide training for national and facility HAI surveillance team members on basic and advanced data analysis techniques.

11.3.4 Best practices: facility level

Regularity of data analysis

Data should be analysed regularly on a monthly or quarterly basis to monitor infection trends and identify potential outbreaks.

Use of basic analytical tools

- HAI surveillance teams and data analysts should utilize basic tools such as spreadsheets or simple statistical software for data analysis.
- Basic calculations, such as infection rates (incidence and prevalence) should be performed and data visualizations should be developed, such as charts and graphs.

Focus on key metrics

- Key simple metrics relevant to the facility should be used, such as infection rates (incidence or prevalence) by ward, procedure or patient population.
    - Identify areas with higher infection rates and investigate potential causes.
    - Creating simple graphs and charts (for example, line graphs, bar charts) can allow the visualization of trends over time or according to a selected ward and patient characteristics. This can help to identify changes or patterns in these epidemiologic measures.
    - Comparing of facility data to reference data. This depends on the availability of suitable reference data using comparable methods, for example, national reference data.
    - Provide training to IPC team members in basic data analysis techniques and the use of relevant tools.
    - Encourage ongoing education to improve analytical skills and stay updated on best practices.

11.4 Interpretation of health care-associated infections surveillance data

11.4.1 Background: national level

Interpreting HAI surveillance data is critical for transforming raw data into actionable interventions. This process involves understanding the significance of the data in terms of measures of infections and trends. Interpreting HAI surveillance data provides a macro-level view of infection trends, helping public health authorities to identify national priorities and formulate IPC policies.

11.4.2 Background: facility level

Facility-level HAI surveillance teams should be able to interpret HAI data to understand local infection dynamics, identify risk areas, implement IPC improvements and evaluate IPC interventions. They should interpret HAI surveillance data in collaboration with the facility IPC committee or senior health care staff.

11.4.3 Best practices: national level

Contextualize data

- HAI surveillance data should be placed within the broader context of national health trends and public health priorities.
- Demographic, geographic, and health care system factors should be considered that might influence HAI rates.
- HAI surveillance data should be interpreted to identify health care facilities where IPC quality improvement is needed to lower the risk of HAI.

Identification and analysis of trends and patterns

- Data should be analysed over time to identify trends, such as seasonal variations or long-term changes in infection rates.
- Patterns in data should be looked for that might indicate emerging threats or areas needing intervention.

Benchmarking

- National HAI data should be compared against international benchmarks or historical data to evaluate performance.
- Standardized HAI surveillance case definitions and methodologies should be used to ensure valid comparisons.

Risk factor analysis

- Risk factors associated with HAI should be identified and analysed, such as specific procedures, patient populations, or health care practices.
- This analysis could be used to target interventions and allocate resources effectively.

Policy implications

- Findings should be interpreted in the context of existing IPC policies and guidelines.
- Recommendations for policy adjustments or new initiatives should be provided based on data insights.

11.4.4 Best practices: facility level

Contextualize data

- HAI surveillance data should be interpreted considering the specific context of the facility, including patient demographics, types of services provided and local health conditions.
- The health care facility HAI surveillance lead/team should engage with frontline staff to gather insights and contextual information that can inform data interpretation.

Identification and analysis of trends and patterns

- Infection trends should be monitored over time within the facility to detect increases or decreases in HAI rates.
- This information should be used to assess the impact of IPC interventions and identify potential outbreaks early.

Detailed examination

- A detailed analysis of specific infections or departments should be conducted to understand the underlying causes of high infection rates.
- Contributing factors should be identified to develop targeted solutions.

Actionable insights

- Data should be translated into actionable recommendations for IPC improvements.
- Findings should be communicated clearly to all relevant stakeholders, including health care workers, administrators, and policy-makers.

Continuous improvement

- HAI data interpretation should be used as part of a continuous quality improvement process.
- IPC strategies should be regularly reviewed and adjusted based on the latest data and feedback from staff.

11.5 Communication/feedback of health care-associated infections surveillance data

11.5.1 Background: national level

Effective communication and feedback of HAI surveillance data are essential for ensuring that the data collected lead to meaningful actions. This involves sharing HAI surveillance reports with all relevant stakeholders, ranging from health care workers to policy-makers, in order to foster a culture of transparency, accountability, and continuous improvement. At national level, the communication of HAI surveillance data helps coordinate efforts across health care facilities, informs public health strategies, and ensures that IPC national policies are based on the latest evidence.

11.5.2 Background: facility level

At the facility level, communication of HAI surveillance data ensures that health care workers are informed about infection risks and motivated to implement IPC measures. Clear communication supports timely and effective responses to emerging threats.

11.5.3 Best practices: national level

Develop a national communication plan

- A structured plan should be created for disseminating HAI surveillance data, including the frequency and format of reports.
- All relevant stakeholders, including health care facilities, public health officials, civil societies and policy-makers should receive the data.

Develop regular national reports

- Regular national HAI surveillance reports that summarize data, identify trends and provide actionable recommendations should be made available.
- Clear and concise language should be used to make the reports accessible to a broad audience, supported by graphs and tables.

Stakeholder engagement

- Engagement with stakeholders should be through meetings, webinars, and workshops to discuss HAI data and gather feedback.
- Discussions as to how the results will be communicated should occur through country networks to promote consistency and alignment of communications.
- A collaborative environment should be fostered where health care facilities can share their best IPC practices and challenges.

Data transparency

- Transparency of HAI surveillance data should be promoted by making national HAI data publicly available, while ensuring patient confidentiality.
- HAI surveillance data dashboards or online platforms should be used to provide real-time access to HAI data and trends.

Tailored feedback

- Provide tailored feedback to individual health care facilities, highlighting their performance relative to national benchmarks.
- Specific recommendations should be offered for IPC improvement based on the facility's data.

11.5.4 Best practices: facility level

Create facility-specific reports

- Regular reports should be developed that summarize HAI surveillance data for the facility, including infection rates, trends, and key findings.
- Visuals should be used to enhance understanding, such as charts and graphs.

Engagement of health care workers

- Regular meetings should be held with health care workers to discuss HAI data and implications for clinical practice.
- Feedback and suggestions should be encouraged from staff on how to improve IPC measures.

Use of multiple communication channels

- Various communication channels should be utilized to disseminate HAI data, such as email updates, bulletin boards, and intranet portals.
- Ensure that all staff members should have access to the information, ranging from frontline workers to administrators.

Timely feedback

- Provide timely feedback on HAI data to enable prompt action in response to any identified issues.
- Highlight successes and areas for improvement to maintain motivation and accountability.

Training and education

- Incorporate HAI data findings into ongoing training and education programmes for health care workers.
- Use data to illustrate the importance of IPC practices and the impact of effective infection control.

11.6 Monitoring and evaluation of health care-associated infections surveillance systems

11.6.1 Background: national level

Regular monitoring and evaluation of HAI surveillance systems are critical for ensuring their effectiveness, identifying areas for improvement, and adapting to changing circumstances. At national level, monitoring and evaluation of the HAI surveillance system helps to assess the overall impact of infection control measures, ensure data quality and inform policy decisions. Continuous improvement of the surveillance system is essential for addressing new challenges and optimizing resource allocation. The national IPC committee in collaboration with the national technical HAI multidisciplinary group should take the lead in the monitoring and evaluation of the HAI national surveillance system.

11.6.2 Background: facility level

At the facility level, monitoring and evaluation of the HAI surveillance system ensures that IPC practices are effective and that data collected are used to improve patient safety. Regular evaluation helps to identify gaps and implement corrective actions promptly. The health care facility IPC committee should review the surveillance system on a regular basis during committee meetings and conduct an annual review to realign surveillance objectives if indicated. They should assess the outcomes to which the surveillance system contributes, for example, evaluate how information produced by the surveillance system is used to reduce the risk of HAI.

11.6.3 Best practices: national level

Implement regular reviews

- Periodic reviews of the national HAI surveillance system should be scheduled to assess its performance and relevance.
- Predefined indicators should be used to evaluate the system's effectiveness, such as data completeness, timeliness, and accuracy.

Assess health care facility compliance

- Health care facilities' adherence to surveillance protocols and reporting requirements should be monitored.
- Feedback and support to facilities should be provided to improve compliance and data quality.

Evaluate timeliness

- Timeliness of data collection, analysis, and dissemination should be assessed.
- Bottlenecks in the process should be identified for improvements.

Continuous system updates

- The HAI surveillance system should be regularly updated to incorporate new technologies, methodologies, and best practices.
- Flexibility of the HAI surveillance system should be maintained and adaptable to changing health care environments.

Outcome evaluation

- The impact of HAI surveillance on infection rates and patient outcomes should be evaluated at least annually.
- Evaluation findings should be used to refine national IPC policies and interventions.

11.6.4 Best practices: facility level

Conduct regular evaluations

- Regular evaluations of the facility's HAI surveillance system should be scheduled at least annually.
- Specific metrics should be used to assess the system's performance, such as infection rates, data quality, and timeliness of reporting.

Review surveillance objectives

The objectives of the HAI surveillance system should be periodically reassessed and adjusted based on evaluation findings and changing health care needs to ensure that they remain relevant and aligned with the facility's goals.

Analyse impact on IPC practices

- Methods of utilization of the HAI surveillance data to inform and improve IPC practices should be evaluated.
- The effectiveness of interventions implemented in response to surveillance findings should be assessed.

Stakeholder involvement

- Key stakeholders, including health care workers, administrators and IPC teams should be involved in the evaluation process.
- The feedback of the stakeholders should be used to identify challenges and opportunities for improvement.

Document and share findings

- The results of evaluations should be documented and shared with relevant stakeholders.
- Evaluation findings should be used to guide continuous improvement efforts and inform future planning.

Utilize criteria to evaluate how the HAI surveillance information provided data on HAI occurrence for decision making *(48)*

- Did the surveillance system detect clusters or outbreaks when the right methodology was used for this purpose?
- Which patient/resident care practices were changed based on surveillance data?
- Were data used to assess the efficacy of interventions?
- Were data used to make procedural changes to decrease the endemic rate of infection?
- Is surveillance data of a special type of 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)?

Table 6 provides a summary of HAI surveillance best practices at national and facility levels by surveillance element.

Table 6. Summary of HAI surveillance best practices at national and facility levels by surveillance element

National-level best practices	**Facility-level best practices**
Develop a national-level HAI surveillance plan including the items given below.	Develop a facility-level HAI surveillance plan in alignment with the national plan including the items given below.
HAI surveillance planning	
National-level best practices	**Facility-level best practices**
Determine who is responsible for HAI surveillance.	Determine who is responsible for HAI surveillance.
Establish goals and objectives of HAI.	Establish goals and objectives of HAI surveillance.
Allocate resources.	Allocate resources.
Identify methods of HAI surveillance.	Define methods of HAI surveillance in alignment with national methods.
Identify types of HAI to be assessed.	Identify facility priority types of HAI within the context of the national types of infections
Agree on standardized HAI case definitions.	Use national HAI surveillance case definitions
Select health care facilities to conduct HAI surveillance.	
Determine the time period of HAI surveillance.	Follow the recommendations of the national HAI strategic plan.
Facilitate the exchange of HAI surveillance information between facilities to share experiences and training.	Facility administration should promote collaboration among IPC/HAI surveillance and health care staff through meetings, webinars, etc.

Table 6 (continued). Summary of HAI surveillance best practices at national and facility levels by surveillance element

Data collection of HAI surveillance data	
National-level best practices	**Facility-level best practices**
Develop standardized HAI surveillance data collection protocols and tools.	Follow the national standardized HAI surveillance data collection protocols.
Suggest who should be responsible for HAI surveillance data collection at facility level.	Identify who is responsible for HAI surveillance data collection at facility level.
Identify sources of HAI surveillance data collection at facility level.	Identify facility sources of HAI surveillance data collection.
Establish reporting mechanisms and structure for reporting HAI surveillance data from health care facilities to the national level.	Provide and share HAI surveillance data in a way consistent with the national HAI surveillance database structure.
Check quality of HAI surveillance data received.	Check and improve quality of HAI surveillance data.
Develop a national HAI surveillance database to aggregate surveillance data received from health care facilities.	Develop a facility HAI surveillance database.
Provide continuous training and education to health care facilities in HAI surveillance data collection protocols and procedures.	Ensure that the facility IPC/HAI surveillance team are well trained in HAI surveillance data collection.
Ensure compliance with relevant laws and ethical standards for data collection.	Ensure compliance with national ethical standards for data collection.
Analysis of HAI surveillance data	
National-level best practices	**Facility-level best practices**
Analyse HAI surveillance data at national level on regular basis (at least once annually).	Analyse HAI surveillance data on a regular basis (monthly or quarterly).
Identify national HAI indicators.	Focus on key metrics relevant to the facility.
Training of data analysts at national and facility levels.	Facility-level data analysts should utilize basic analytic tools, calculations and simple metrics.
Interpretation of HAI surveillance data	
National-level best practices	**Facility-level best practices**
Contextualize HAI surveillance data within the broad context of national health trends.	Contextualize HAI surveillance data within the context of the health care facility and engage frontline staff in the interpretation process.
Identify patterns and trends of infections to identify emerging threats or areas needing interventions.	Monitor infection trends over time within the facility to detect changes in HAI rates and to assess the impact of interventions.
	Explore the underlying aetiology of the high infection rates (if any).
Benchmark national HAI surveillance data against international benchmarks.	Benchmark facility-level HAI surveillance data against other facilities.

Table 6 (continued). Summary of HAI surveillance best practices at national and facility levels by surveillance element

Interpret HAI surveillance data within existing national IPC policies and guidelines	Interpret HAI surveillance data within existing facility-level IPC policies and guidelines and continuously adjust IPC strategies.
	Translate HAI surveillance data into actionable IPC recommendations and interventions.
Communication/feedback of HAI surveillance data	
National-level best practices	**Facility-level best practices**
Develop a national HAI surveillance communication/feedback plan.	Develop a facility-level HAI surveillance communication/feedback plan.
Identify the national- and facility-level stakeholders to communicate with and share the HAI surveillance results.	Identify the facility-level stakeholders to communicate with and share the HAI surveillance results.
Develop national HAI surveillance reports, including important national summaries of HAI surveillance data.	Develop facility-level HAI surveillance reports to summarize facility-level HAI surveillance data.
Engage with national stakeholders through meetings, webinars, and workshops.	Engage with facility stakeholders through meetings and webinars to discuss HAI surveillance results.
Make HAI surveillance data publicly available (if possible) while ensuring patient confidentiality.	Publish HAI surveillance data at the facility level.
Distribute the national HAI surveillance report to national and facility stakeholders.	Distribute the HAI surveillance report to facility stakeholders in a timely manner.
Provide tailored feedback to health care facilities including specific IPC recommendations for improvement.	Provide tailored feedback to facility stakeholders, including specific IPC recommendations for improvement.
Incorporate HAI surveillance findings in the training and education programmes for health care workers.	Incorporate HAI surveillance findings in the training and education programmes for health care workers.
Monitoring and evaluation of HAI surveillance	
National-level best practices	**Facility-level best practices**
Implement periodic reviews of the HAI surveillance system elements on a regular basis.	Implement periodic reviews of the HAI surveillance system elements on a regular basis.
Assess health care facilities' adherence to surveillance protocols, timeliness of data collection, analysis, reporting requirements and dissemination.	Assess adherence of the facility to all HAI surveillance elements.
Conduct continuous HAI surveillance system updates to incorporate new technologies, and best practices.	Use monitoring and evaluation results to update and modify the HAI surveillance system so as to incorporate new technologies and best practices.
Evaluate the impact of HAI surveillance on the reduction of HAI.	Evaluate the impact of HAI surveillance on the reduction of HAI.
Share results of evaluations with national stakeholders.	Share results of evaluations with facility-level stakeholders.
Utilize evaluation findings to inform future planning.	Utilize evaluation findings to guide continuous improvement efforts and inform future planning.

Abbreviations: HAI, health care-associated infection(s); IPC, infection and prevention control.

12. Surveillance in public health emergencies

Outbreaks can spread rapidly through the community and be significantly amplified in health care settings. Health care-associated transmission poses significant challenges during public health emergencies and can exacerbate the burden on health care systems already strained by the crisis. Effective HAI surveillance is crucial for early detection, containment and mitigation of health care-associated outbreaks to ensure the safety of patients and health care workers. The dynamic and often unpredictable nature of public health emergencies necessitates a robust surveillance system that can adapt to rapidly changing conditions and provide timely, actionable data.

12.1 Objectives of health care-associated infections surveillance during public health emergencies

1. **Early detection of cases and outbreaks**: timely identification of suspected cases and outbreaks within health care settings allows for targeted interventions to minimize the risk of initiating or amplifying outbreaks and prevents onward transmission to the community.
2. **Monitoring the HAI burden**: understanding the burden of HAI helps assess the effectiveness of IPC measures used during the response. It also monitors unintentional harms to patient safety caused by measures implemented to maintain essential health services during public health emergencies.
3. **Informing IPC strategies**: adapting IPC strategies to the evolving context of public health emergencies ensures that interventions meet the unique circumstances of local health care systems. This informs prevention strategies in both health care and community settings.
4. **Rational resource allocation**: ensuring that resources are allocated and re-allocated based on the specific needs of IPC interventions, which may diverge from broader epidemiological patterns.
5. **Data for decision-making**: using incidence and investigation data to guide decision-making, resource allocation and policy formulation during the response and recovery phases of public health emergencies.

12.2 Health care-associated infections surveillance integration with early warning, alert and response (EWAR) systems

Incident and event-based surveillance mechanisms, such as EWAR systems, can be adapted to generate alerts for suspected HAI, thus enabling a timely notification of cases and outbreaks during public health emergencies. EWAR systems established in health care settings and powered by local clinical expertise identify and report suspected cases of priority diseases or conditions to relevant health authorities. Enhancing these systems involves incorporating IPC measures to ensure safe screening practices and protocols for immediate implementation upon identification of suspected cases.

12.2.1 Considerations for integrating health care-associated infections alerts into EWAR systems

Incident-based surveillance

- The system must report when a current inpatient develops new symptoms meeting an associated case definition.
- Essential reporting information includes ‘date(s) of admission’ and ‘date of symptom onset’ for current inpatients or readmissions suspected of having an HAI.
- Examples of signs and symptoms of interest include the onset of respiratory symptoms, acute watery diarrhoea, and suspected infectious rashes.

Event-based surveillance

- The system must have pre-established criteria to report priorities for suspected clusters and outbreaks in health care facilities.
- An example of an event of interest is an unusual increase in patients with compatible symptoms of infection after admission to a health facility, linked by similar exposure to the same room, ward, or procedure.

13. New WHO health care-associated infections surveillance case definitions

13.1 Importance of using standardized health care-associated infections case definitions

Standardized and validated HAI case definitions are essential for effective surveillance and monitoring of HAI. They facilitate benchmarking and allow countries and facilities to compare their HAI rates with national, regional or international data and support research efforts by providing a common criterion for studying HAI.

Until now, no universally agreed-upon, standardized HAI case definitions for global use have been available, in particular for low-resource settings. The US CDC and ECDC offer standardized HAI surveillance definitions, which are widely used in many countries *(12,13).* The validity and reliability of both US CDC and ECDC case definitions are well-established and both sets of definitions have been recognized as international standards *(49)*. However, these definitions rely on a level of laboratory, diagnostic, imaging and epidemiological capacity that may not be achievable in low-resource settings. This reliance can constrain HAI surveillance or lead to inaccurate data in these environments *(50)*.

Each country should adopt a set of national HAI case definitions included in their national HAI strategic plan. To ensure these definitions are consistently applied in all health care facilities conducting HAI surveillance, several steps are necessary. These include training hospital teams in the consistent and correct application of case definitions and periodically assessing these teams' adherence to the definitions.

13.2 New WHO simplified health care-associated infections surveillance case definitions: 2024

To address the limitations of applying the available standardized HAI case definitions, such as those from US CDC and ECDC (*12,13*), in settings with limited resources, WHO organized four dedicated technical consultations between 2019 and 2024. These consultations included over 30 international, regional and national experts on HAI surveillance and resulted in the development of a set of draft simplified HAI case definitions based on US CDC and ECDC definitions according to expert advice and consensus voting. The focus was on modifying definitions for the most common HAI, including BSI, UTI, SSI and pneumonia.

The simplified definitions aim to be more feasible for use in settings with limited resources to ensure accurate and consistent data collection and reporting, while minimizing the burden on health care facilities. These adapted definitions help to improve the quality and comparability of HAI surveillance data across diverse health care environments.

13.3 Validation of the WHO simplified health care-associated infections surveillance case definitions

The draft WHO simplified HAI case definitions were validated by undertaking a concordance study through a point prevalence survey to compare WHO definitions to the ECDC definitions *(13).* The pilot validation study was undertaken in nine countries representing several WHO regions and including 18 acute-care hospitals between May and December 2023.

The point prevalence study was restricted to adults ≥18 years and assessed the four HAI types for which WHO had simplified the definitions. Patients present in the hospital wards at 08:00 and not discharged during the time of the survey were included. Data were collected by hospital IPC teams trained by WHO on the study protocol and an electronic data collection application developed for the purpose of this study. A total of 5557 patients were included in the study.

Among all patients, 992 (17.9%) had a HAI according to WHO definitions, while 648 (11.7%) had a HAI according to ECDC case definitions. For the BSI case definition, the overall concordance between WHO and ECDC definitions was high at 95.1% and sensitivity and specificity estimates were 100% and 94.9%, respectively. For the UTI case definition, the overall concordance was 99.6% and sensitivity and specificity estimates were 94.7% and 99.7%, respectively. For the SSI case definition, the overall concordance was 97.9% and sensitivity and specificity estimates were 98% and 97.8%, respectively. For the pneumonia case definition, the overall concordance was 95.7% and sensitivity and specificity estimates were 80.0% and 96.2%, respectively.

WHO and international experts evaluated these results and, based on the overall high level of concordance between WHO simplified definitions and ECDC HAI definitions, the experts agreed by a very large consensus (90% of agreement or above) that the WHO definitions can be accepted and used. The new WHO case definitions for HAI surveillance regarding BSI, UTI, SSI and pneumonia for use in limited-resource settings are published in Annex 1 for the first time.

WHO emphasizes that other standardized HAI definitions such as those issued by the US CDC or ECDC should continue to be used *(12,13)*, depending on local protocols and systems. WHO also highlights that priority should be given to the use of definitions that provide the highest level of accuracy of the case identification. Therefore, it is preferable to use diagnostic criteria based on microbiology/laboratory testing and/or radiological examinations according to the standardized definitions by WHO, ECDC or US CDC.

14. Additional considerations of health care-associated infections surveillance systems

14.1 Surveillance case definitions versus clinical diagnosis

Both HAI surveillance case definitions and clinical diagnosis involve identifying infections in health care facilities. However, they serve different purposes, have different criteria, and are used in different contexts within health care settings (Table 7).

Table 7. Comparison between HAI surveillance case definitions and clinical diagnosis

	HAI surveillance case definitions	Clinical diagnosis
Purpose	For surveillance and public health purposes.	To guide patient care.
Objective versus subjective	Aims to apply objective criteria.	Applies all available subjective and objective criteria.
Population versus individual	Population level.	Individual level.
Consistency versus accuracy	Consistent.	Accurate.
Temporal aspect	May include a temporal aspect.	Focuses on the current clinical presentation of the patient.

14.1.1 Health care-associated infections surveillance definitions

The aim of HAI surveillance is to identify clinically-significant infections for surveillance purposes. Given the inherent subjectivity in clinical diagnosis, surveillance definitions need to be both clinically and operationally meaningful and are designed to be objective and reproducible within and between facilities. Surveillance case definitions can be robustly applied and be reproducible by different data collectors *(40)*.

Purpose: HAI surveillance case definitions are used to identify and monitor selected infections within health care settings for surveillance and public health response purposes.

Criteria: these definitions are often standardized and based on clinical and laboratory criteria, focusing on objective measures such as signs, symptoms and laboratory results, among others.

Specificity: they are designed to be specific to ensure consistency and comparability of data across different health care facilities.

Usage: they are primarily used for the surveillance of specific populations, trend analysis, benchmarking and guiding IPC measures.

14.1.2 Clinical diagnosis

The aim of a clinical diagnosis is to guide patient care and identify infections for treatment purposes. The clinical diagnosis of infections applies all subjective and objective clinical criteria.

Purpose: clinical diagnoses aim to support the treatment of individual patients with infections based on their specific signs, symptoms and clinical presentation.

Criteria: clinical diagnoses rely on a combination of subjective and objective criteria, including patient history, physical examination, laboratory tests and imaging. They require specific confirmation tests and are usually more detailed.

Flexibility: clinical diagnoses allow for flexibility and individualized assessment, considering patient-specific factors such as comorbidities, clinical course and response to treatment.

Usage: clinical diagnoses guide patient care, including treatment selection, infection control measures, discharge planning and ongoing monitoring of patient progress.

14.2 Political leadership, regulatory considerations and public reporting

14.2.1 Political leadership

The first strategic direction of the global IPC strategy is political commitment and policies. Demonstrating visible leadership engagement at the highest level, is one of the most important elements to successfully achieve effective implementation of the WHO IPC core components and thus will have a great influence on the success of national HAI surveillance systems. In particular, leadership engagement in promoting HAI surveillance can provide a culture of transparency and accountability that supports the identification and reporting of HAI.

14.2.2 Regulatory considerations

The enforcement of the IPC core components, particularly HAI surveillance, should be enabled through legal health systems' regulations, accountability frameworks and accreditation systems. To support these, mobilizing national resources is not only crucial for the sustained financing of IPC programmes, but also essential to accelerate the sustainable implementation of the IPC programme *(3)*.

An excellent example of a legal framework for IPC is the one developed by the Africa CDC in collaboration with WHO and stakeholders and backed by the African Union's Heads of State *(51)*. The IPC legal framework guides Member States in the review and strengthening of laws and policies that support IPC at both the national level and in health care facilities. It also guides IPC operations and captures areas of accountability mechanisms and resources required for implementation, leadership structure, monitoring and evaluation. Examples of legal instruments are a constitution, acts of legislation such as laws and decrees, regulations, and applicable international agreements *(51)*. Countries endorsing an IPC legal framework will ensure a huge impact on the success of their IPC programme as it provides authority to coordinate and implement IPC programmes and core components at all levels of the health care system and to set IPC standards at health care facilities, as well as a system of accountability. It also facilitates continuity of leadership and government support during transitional times and provides a strong basis for IPC funding *(51)*.

14.2.3 Public reporting

Public reporting of HAI surveillance data is used in some countries with the purpose to increase transparency and data sharing. For example, in the USA, mandatory reporting of HAI is required in all states and using public reporting of HAI surveillance was associated with a significant reduction in CLABSI rates 13–18 months after the introduction of this federal policy within states *(52).*

14.3 Digital or automated health care-associated infections surveillance systems

14.3.1 Digital tools for health care-associated infections data collection

Digitalization of health care data creates novel opportunities for enhancing HAI surveillance. Digital tools can support HAI surveillance in different ways. For example, digital applications can support electronic data entry of information to avoid manual data entry, save time and minimize errors in data entry. Applications can also be developed to extract patient data from electronic health information systems (if available). This applies to settings with functioning hospital information systems.

Decision-supported IT digital applications can be used for handling HAI surveillance data (for example, presence of individual criteria) and decision algorithms can help to define the various types of HAI according to the used HAI case definitions. Other digital IPC tools focus on the implementation and evaluation of IPC measures. These applications can play a crucial role particularly for LMICs which are starting to implement HAI surveillance systems, and where the hospital teams still have limited training and expertise to reliably detect HAI. Digital tools that determine the presence of a HAI based on entered information about individual criteria can therefore reduce the likelihood of human error and the subjectivity of detecting and classifying infections. In addition, these tools promote consistency in surveillance practices across different health care settings, thus ensuring uniformity in data reported.

Moreover, digital applications can be developed to have the ability to define and generate automated alerts when certain conditions are met (for example, detection of emerging pathogens). By providing real-time alerts to health care providers, they can help to ensure that appropriate IPC measures are taken. Digital applications can also be developed to support the electronic transfer of data from facilities to the national level and to facilitate the merge of facility-level data into the national HAI database.

14.3.2 Automation of health care-associated infections surveillance

Conventional 'manual' surveillance of HAI is usually done through a manual review of patients' medical records to identify HAI according to standardized HAI surveillance case definitions. Manual HAI surveillance is therefore associated with a high workload and a potentially limited interrater reliability *(53, 54).* As a result, manual surveillance is often restricted to presumed high-risk areas and selected types of infections.

Automated surveillance systems offer the potential to overcome these limitations by providing mechanisms to include more health care areas, patients and infections into the surveillance and by being more reproducible. While automated surveillance brings multiple challenges (for example, data availability and interoperability, data protection regulations, IT infrastructure and knowledge) and thus also requires considerable resources to be set up and maintained, these systems offer the potential to save and subsequently re-allocate health care resources.

Automated surveillance systems have been developed for various types of HAI *(55)* and automation of surveillance can be applied to varying degrees. Conventionally, a distinction is made between fully and semi-automated surveillance. In fully automated surveillance, all steps for the identification of HAI (data collection, interpretation of data, ascertainment of HAI) are performed autonomously by the automated surveillance algorithm. In semi-automated surveillance, detection algorithms identify patients with a high probability of meeting case definitions for an infection. Final ascertainment whether pre-selected patients truly have a HAI remains a human task. Thus, manual chart review may remain a component of semi-automated surveillance systems, but the number of charts that need to be manually reviewed becomes substantially smaller *(56)*. Of note, the automation of HAI surveillance may require adapting existing HAI case definitions or establishing new surveillance metrics entirely (for example, hospital-onset bacteremia *(57)*).

Automated surveillance systems vary in complexity, functionality and implementation requirements. Implementation of automated surveillance is possible at the local (that is, health care facility) and regional/national ('central') level. However, in both cases, a high degree of data standardization is required. While a centrally-implemented automated surveillance system may help to accommodate facilities that do not have the necessary resources to set up locally such a system, they come with particular challenges concerning data protection regulations.

In Europe, the PRAISE (Providing a Roadmap for Automated Infection Surveillance) network was initiated in 2019 to develop conceptual guidance for the development and transition to large-scale automated surveillance systems. It pays extensive attention to the selection of surveillance targets and definitions and the design of such systems (including the selection and requirements of data sources and algorithms). It also discusses implementation considerations, data interoperability, validation, maintenance, and areas of future research *(58, 59)*. Governance aspects are of particular importance in large-scale automated surveillance systems, including engagement of stakeholders, transparency of algorithms and accountability, as well as the legal and ethical principles regarding the reuse of personal data for the purpose of surveillance *(60).*

14.3.3 Need for national automated surveillance systems

Most automated surveillance methods to detect HAI have been developed and implemented in research settings and information about the feasibility of large-scale implementation is scarce *(55)*. Development of large-scale national automated surveillance systems can support the uniform collection of surveillance data across facilities, while also being suitable for quality improvement at the facility level. Facility-level automated surveillance systems are usually heterogeneous, which can limit their contribution to reference data of a national HAI surveillance programme.

Several aspects have to be considered when developing national automated surveillance systems. Examples are privacy, data sharing, data security, ethical considerations, laws and regulations on data reporting, as well as data protection (*60)*.

Countries with an interest in investing in automated surveillance systems need to develop a harmonized automated approach to surveillance that suits their local situation and results in data supporting comparison and quality improvement. A first step in going forward will be to choose an approach to implementation and achieve consensus on the targets for automated HAI surveillance and their definitions as this will form the basis of all further development efforts.

15. Challenges and solutions in the context of health care-associated infections surveillance

Designing and implementing HAI surveillance systems involve various challenges, which can differ based on health care system structures, infection control practices, and available resources. In LMICs, more challenges are anticipated related to limited political support, insufficient national budgets and competing health care priorities *(61-63)*. Other barriers include understaffing, shortages of basic laboratory equipment and insufficient quality of the microbiology laboratory results, and limited motivation to report HAI *(64, 65)*. The 2022 WHO global IPC report highlighted the common challenges in implementing the WHO core components for IPC across all regions. The most significant challenges for HAI surveillance included a lack of expertise and the need for substantial financial investment *(66)*.

This chapter will explore the challenges of instituting HAI surveillance at both the national and health care facility levels. Each country should conduct its own assessment to identify gaps and develop solutions tailored to its local context.

15.1 Challenges

15.1.1 Economic constraints and political support

These can significantly limit investment in IPC and HAI surveillance. In many countries, the substantial economic cost of HAI is not fully recognized, leading to a lack of prioritization for HAI surveillance and infection control activities.

- **Limited funding:** in many countries, particularly those with limited resources, HAI surveillance activities are often seen as a luxury and are not funded or sustained. This is compounded by the challenge of securing long-term support and funding for surveillance activities.
- **Political support:** lack of political commitment hinders the successful implementation of HAI surveillance systems. Visible leadership engagement can foster a culture of transparency and accountability, which is essential for effective HAI surveillance.
- **Political instability:** in some countries, frequent political instability can disrupt HAI surveillance activities, despite the potential for preventing HAI to significantly reduce patient morbidity and mortality.
- **Lack of national IPC policies:** many countries lack national IPC policies and, in some cases, a large proportion of hospital care is provided by the private sector, which may not prioritize IPC initiatives

15.1.2 Limited capacities and human expertise

Human resources are essential for implementing effective HAI surveillance and infection control measures. In many LMICs, there is a significant shortage of the necessary expertise and capacities as outlined below.

- **Strategic planning and protocol development:** limited capacity to develop national strategic plans and protocols for HAI surveillance can lead to inconsistent and unreliable national data due to variability in data collection methods, HAI case definitions and reporting practices.
- **Standardized case definitions:** the complexity of internationally available HAI case definitions (for example, NHSN, ECDC) requires dedicated human resources, funding and expertise, which many countries lack.

- **Infectious disease expertise**: lack of physicians trained in health care epidemiology, which is crucial for supporting HAI surveillance.
  Data analysis expertise: there is a shortage of staff with the expertise to regularly analyse national- or facility-level HAI surveillance data.
- **Microbiology laboratory capacity:** insufficient microbiology capacity can lead to underreporting of HAI due to a lack of diagnostic resources and patient-linked laboratory data. The emergence of antimicrobial-resistant pathogens further complicates surveillance efforts.
- **Data quality:** ensuring accurate and consistent data collection, applying standardized HAI case definitions, and analyzing data across different facilities is difficult.
- **Data reporting and analysis:** establishing systems for the timely reporting and analysis of data is challenging, particularly in resource-limited settings.
- **Use of data for action:** a key challenge at the facility level is the lack of IPC practitioners who can interpret HAI surveillance data and implement specific IPC measures to reduce infections.

15.1.3 Limitations in health care systems' capacities

Health care system variability and limitations present significant challenges to supporting HAI surveillance systems and these are outlined below.

- **Diagnostic capacity:** many low-resource countries have limited microbiology and laboratory support, which affects the quality and accuracy of HAI surveillance data. Differences in diagnostic methods and capabilities can impact on the accuracy and comparability of surveillance data.
- **IT capacities:** limited IT infrastructure hinders data extraction, electronic reporting, and integration of data from various systems (for example, electronic health records, laboratory systems, IPC databases).
- **Data sharing:** challenges in sharing data between health care facilities and national public health agencies can impede effective surveillance.
- **Integration issues**: challenges in integrating data from various sources, such as laboratory data and patient demographics, can affect the reliability and comparability of surveillance data.
- **Interdisciplinary collaboration:** limited collaboration between disciplines at both national and facility levels can affect the implementation and success of HAI surveillance systems.
- **Surveillance culture:** a lack of awareness and commitment to surveillance within health care facilities can further complicate implementation efforts.

15.2 Solutions for implementing a health care-associated infections surveillance system

Addressing the challenges of HAI surveillance requires a multifaceted approach that includes securing resources, building capacity and strengthening health systems. This chapter outlines key solutions to enhance HAI surveillance effectiveness at both national and facility levels.

15.2.1 Reducing resource constraints and improving political support

National IPC and HAI surveillance teams should advocate for the importance of HAI surveillance by using research data and surveillance findings that highlight the burden of HAI and AMR. This advocacy can build a strong case for sustained government funding to improve HAI surveillance infrastructure and systems. By demonstrating the cost-effectiveness and public health benefits of effective HAI surveillance, these teams can secure the political commitment needed to ensure long-term support.

15.2.2 Capacity building and workforce expansion

As HAI surveillance systems evolve, it is essential to develop a skilled workforce capable of designing and implementing effective HAI surveillance and IPC programmes. Countries should focus on the following elements listed below.

- **Comprehensive training programmes:** develop and implement education and training programmes for IPC and HAI surveillance teams covering HAI surveillance methodologies, data collection, analysis, interpretation, communication and evaluation. Ongoing professional development is critical to keeping staff informed of the latest best practices.
- **Collaboration with academic institutions:** academic institutions and professional organizations can create specialized courses and certifications in HAI surveillance, ensuring a well-trained cadre of professionals at the national and facility levels.
- **Health care facility support:** national surveillance groups, in collaboration with stakeholders, should provide technical assistance, standardized protocols and resources to health care facilities. Facilitating peer learning and knowledge exchange among facilities can foster continuous improvement in surveillance practices.
- **On-site mentorship:** implement a system of intensive on-site mentorship and regular visits to participating hospitals to maintain consistency and ensure data quality across the board.

15.2.3 Strengthening health care systems and IT

Strengthening health care systems is crucial to supporting effective HAI surveillance. Key areas of focus are listed below.

- **Enhancing laboratory capacities:** invest in laboratory infrastructure, ensure the availability of essential supplies, and develop robust microbiology capacities to support accurate HAI diagnosis and surveillance.
- **Improving health care infrastructure:** upgrading the health care facility infrastructure, including water, sanitation, and hygiene facilities, contributes to stronger IPC programmes and better surveillance outcomes.
- **Leveraging IT:** implement IT solutions to streamline data collection, analysis and reporting processes. This reduces administrative burdens on health care personnel and ensures more efficient and accurate surveillance.
- **Integrating surveillance systems:** use IT platforms to link various surveillance programmes, such as the *Global Antimicrobial Resistance and Use Surveillance System* (GLASS), to improve IPC practices through comprehensive data analysis.

16. Success stories of health care-associated infections surveillance

The implementation of HAI surveillance systems has been successful in various countries, for example, in the USA, Canada, Germany, Brazil, Croatia, the Netherlands, and several LMICs. These systems have been effective in monitoring and reporting infection rates, leading to improved IPC efforts. We are providing some country examples that were identified based upon published and unpublished evidence *(67–69)* of specific efforts to establish and/or sustain successful HAI surveillance systems and activities. Furthermore, they were identified in agreement with the respective WHO regional and country offices and each country example was reviewed and approved by the Ministry of Health. They were also selected taking geographical and income level balance into account.

16.1 Health care-associated infections surveillance in Germany

Patient and health care worker safety has been a central focus of the German government for many years. Hospitals in Germany are mandated by the German Infection Protection Act to perform surveillance for HAI relevant to their facilities. The surveillance data must be analysed, reported internally, and used to guide the implementation of IPC measures. HAI surveillance is coordinated by a national, voluntary and confidential HAI surveillance system known as KISS (*Krankenhaus-Infektions-Surveillance-System* [Hospital-Infection-Surveillance-System]).

Germany's organized efforts in HAI surveillance began in 1994 with the first national prevalence study (NIDEP; *Nosokomiale Infektionen in Deutschland – Erfassung und Prävention*; [Nosocomial infections in Germany – assessment and prevention]). This study investigated the frequency of nosocomial infections in a representative selection of hospitals across the country in the context of a quality assurance programme funded by the German Federal Ministry of Health *(70, 71)*.

Discussion of the findings of the NIDEP study raised the question of how many of these nosocomial infections were preventable. In response, the Federal Ministry of Health provided additional funding in 1995 for a second study, known as NIDEP-2 *(72)*, which was inspired by the Study on the Efficacy of Nosocomial Infection Control (SENIC project) conducted earlier by the US CDC among US hospitals *(73)*. NIDEP-2 was a prospective, controlled, intervention study focused on preventing HAI in intensive care and surgical departments using HAI surveillance and data feedback to health care workers in so-called 'quality circles' as a principal Intervention instrument. The study contributed to the development of a pool of national experts in the field of HAI surveillance.

The birth of KISS

To create a sustainable infrastructure for ongoing HAI surveillance, the Federal Ministry of Health commissioned the establishment of a national HAI surveillance system. This led to the conception of KISS, initially with just two modules, one for HAI in ICUs and one for surgical departments. To disseminate the surveillance definitions and overall methodology, the first KISS introduction and training course took place in 1996. As an integral part of the introduction course, case vignettes were used to train the newly-taught methods and definitions. KISS officially began in 1997 with a small number of hospitals participating in the two initial modules *(74).*

Since its inception, KISS has grown significantly, with over 1000 hospitals participating today. It has expanded to include numerous modules covering various clinical areas such as ICUs, surgical departments, neonatology, hematology-oncology, non-ICU wards, outpatient dialysis, multidrug-resistant organisms and alcohol-based hand rub consumption. KISS provides participating hospitals with well-established methods, access to reference data and comprehensive support, which has proven crucial in reducing infection rates in

multiple patient populations. Continuous surveillance and feedback within the KISS framework have been associated with significant improvements in infection control outcomes *(74, 75).*

Key aspects enabling successful surveillance in Germany

A key characteristic of KISS is its modular structure, which allows health care facilities to focus on specific aspects of surveillance depending on their local situation. This approach facilitates a manageable entry into the subject matter and enables hospitals to concentrate on particular areas of interest, such as specific types of surgery, while gradually expanding their surveillance activities. It also provides the flexibility to monitor a wide variety of patient populations, each with their own unique risks, by offering tailored methods suited to different clinical settings. This ensures that appropriate surveillance strategies are in place for diverse patient groups.

The National Reference Centre for Surveillance of Nosocomial Infections, which organizes and oversees the KISS network, provides training courses and resources for participants to enhance methodological consistency across facilities. Annually, introduction courses and KISS exchange meetings offer opportunities for knowledge sharing and collaboration, thus helping to foster a strong surveillance network across Germany. In addition, a secure online data management portal (webKess) has been developed for participating hospitals and allows efficient data entry and transfer to the national reference centre. This portal also enables facilities to independently evaluate their surveillance data over customizable time periods, providing a basis for timely feedback and data interpretation. Importantly, the data are handled confidentially. While pooled reference data are published, the individual data of specific facilities remain

Attributes of success of the German HAI surveillance system

- ☑ Simplicity
- ☑ IPC reinforced by legislation within the German federal law
- ☑ Different modules to address specific clinical areas
- ☑ Strong national reference centre
- ☑ User-friendly online management portal
- ☑ Confidential data handling/only pooled data published
- ☑ Emphasis on fostering collaboration and networking

protected and are not shared with others. In summary, KISS has provided a framework for a sustained reduction of HAI in Germany and the improvement of patient safety across the country.

16.2 Health care-associated infections surveillance in Viet Nam

In 2016, the Viet Nam Administration for Medical Services (under the Ministry of Health), US CDC and PATH (Program for Appropriate Technology in Health) collaborated to establish a standardized HAI surveillance system for BSI and UTI among selected ICUs at six hospitals. Following its development, five elements leading to the success of this surveillance system were identified: engaging stakeholders; designating roles and responsibilities among stakeholders; developing context-appropriate surveillance protocols; creating a surveillance implementation strategy; and linking HAI surveillance data to HAI prevention activities. The HAI surveillance system gradually expanded and 50 hospitals across the country now collect and report data to the Ministry of Health on a regular basis *(76).*

Attributes of success of the Viet Nam HAI surveillance system

- ☑ Engaging stakeholders
- ☑ Designating roles and responsibilities
- ☑ Developing context-sensitive, standardized surveillance protocols
- ☑ Creating a surveillance implementation strategy
- ☑ Linking HAI surveillance and prevention activities

16.3 Health care-associated infections surveillance in Brazil

In Brazil, the HAI surveillance system began in 2009 with the definition of national diagnostic criteria for the main infections and the determination of mandatory monthly reporting of data on central venous catheter-associated BSI occurring in ICUs. Over the past 15 years, the number of infections reported and monitored has gradually increased. During this period, monitoring of the AMR profile of microorganisms causing BSI associated with the use of central catheters, UTI, and bacteraemia occurring in dialysis patients also began. By 2024, monthly infection and AMR data will be reported to the national HAI surveillance system by 2050 hospitals with adult, paediatric and neonatal ICU beds, 2250 hospitals that perform surgical procedures, and 880 dialysis services. In addition to the occurrence of infections, other indicators related to the consumption of alcohol-based hand rub, the central catheter implantation checklist and the consumption of antimicrobials in adult ICUs are also reported and monitored. In total, data on more than 30 indicators are reported every month to the Brazilian HAI surveillance system *(77).*

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Annex 1. WHO health care-associated infection case definitions for use in settings with limited resources

Bloodstream infection(s) (BSI)

Confirmed BSI (BSI-A1)

One positive blood culture for a recognized pathogen. It excludes common skin commensals such as coagulase-negative staphylococci, *Micrococcus* sp., *Propionibacterium acnes*, *Bacillus* sp., *Corynebacterium* sp.

Confirmed BSI (BSI-A2)

Patient has at least one of the following signs or symptoms: fever (> 38°C) ***OR*** chills ***OR*** hypotension (systolic pressure ≤ 90 mmHg);

AND

two positive blood cultures for a common skin commensal(s) (from two separate blood samples) within 48 hours. Common skin contaminants include coagulase-negative staphylococci, *Micrococcus* sp., *Propionibacterium acnes*, *Bacillus* sp., *Corynebacterium* sp.

Suspected BSI (BSI-B)

Patient has at least one of the following signs or symptoms: fever (> 38°C) ***OR*** chills ***OR*** hypotension (systolic pressure ≤ 90 mmHg);

AND

treatment for infection is instituted (that is, on the day of sample collection, physician documentation of antimicrobial treatment for suspected infection);

AND

one positive blood culture for a common skin commensal(s). Common skin contaminants include coagulase-negative staphylococci, *Micrococcus* sp., *Propionibacterium acnes*, *Bacillus* sp., *Corynebacterium* sp.

Central vascular catheter-associated BSI (CVC-BSI)

BSI-A1 ***OR*** BSI-A2 ***OR*** BSI-B definition met

AND

a central vascular catheter in place ≤ 2 days prior to first meeting a component of the confirmed BSI definition.

Suspected unidentified systemic infection (SUSI)

Patient has at least one of the following signs or symptoms: fever (> 38°C) ***OR*** chills ***OR*** hypotension (systolic pressure ≤ 90 mmHg);

AND

treatment for infection is instituted (physician documentation of antimicrobial treatment for suspected infection);

AND

blood culture not done .

Urinary tract infection(s) (UTI)

Microbiologically-confirmed symptomatic UTI (UTI-A)

Patient has at least one of the following signs or symptoms with no other recognized cause: fever (> 38°C); ***OR*** urinary urgency; ***OR*** increased urinary frequency; ***OR*** dysuria; ***OR*** flank pain; ***OR*** supra-pubic pain; ***OR*** suprapubic tenderness;

AND

a positive urine culture (≥ 10^5 microorganisms per mL of urine with no more than two species of microorganisms).

Not microbiologically-confirmed symptomatic UTI (UTI-B)

Patient has at least two of the following signs or symptoms with no other recognized cause: fever (> 38°C); ***OR*** urinary urgency; ***OR*** increased urinary frequency; ***OR*** dysuria; ***OR*** flank pain; ***OR*** supra-pubic pain; ***OR*** suprapubic tenderness;

AND

at least one of the following findings: positive dipstick for leukocyte esterase and/or nitrate; ***OR*** pyuria with ≥ 10 white blood cell (WBC)/mL or ≥ 3 WBC/high-power field of unspun urine; ***OR*** microorganisms seen on Gram stain of unspun urine; ***OR*** at least two urine cultures with repeated isolation of the same uropathogen (Gram-negative bacteria or *Staphylococcus saprophyticus*) with ≥ 10^2 colonies/mL urine in non-voided specimens; ***OR*** ≤ 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 UTI.

Not microbiologically-confirmed symptomatic UTI (UTI-C)

Patient has at least three of the following signs or symptoms with no other recognized cause: fever (> 38°C); ***OR*** urinary urgency; ***OR*** increased urinary frequency; ***OR*** dysuria; ***OR*** flank pain; ***OR*** supra-pubic pain; ***OR*** suprapubic tenderness;

AND

clinician diagnosis of a UTI ***OR*** clinician institutes therapy for a UTI.

Catheter-associated UTI (CAUTI)

UTI-A ***OR*** UTI-B ***OR*** UTI-C definitions;

AND

an indwelling urinary tract catheter in place ≤ 2 days prior to first meeting a component of the confirmed UTI definition.

Surgical site infection(s) (SSI)

SSI type A (SSI-A)

Postoperative patients within 30 days following a surgical procedure with evidence of SSI based on microbiology (for positive culture); ***OR*** radiology (suggestive of infection); ***OR*** histopathologic criteria (for abscess or similar findings).

Stratify by depth if the following information is available:

a) superficial: AND infection involves only skin and subcutaneous tissue of the incision;

b) deep incisional: AND infection involves deep soft tissue (for example, fascia, muscle) of the incision;

c) organ/space: AND infection involves any part of the anatomy (for example, organs and spaces) other than the incision that was opened or manipulated during a surgical procedure.

SSI type B (SSI-B)

Postoperative patients within 30 days following a surgical procedure with reopening of the wound for suspected infection ***OR*** abscess (or similar findings) found during direct examination or during reoperation (for deep and organ/space SSI).

Stratify by depth if the following information is available:

a) superficial: AND infection involves only skin and subcutaneous tissue of the incision;

b) deep incisional: AND infection involves deep soft tissue (for example, fascia, muscle) of the incision;

c) organ/space: AND infection involves any part of the anatomy (for example, organs and spaces) other than the incision that was opened or manipulated during a surgical procedure.

SSI type C (SSI-C)

Postoperative patients within 30 days following a surgical procedure with evidence of purulent discharge at the incision or surgical site.

Stratify by depth if the following information is available:

a) superficial: AND infection involves only skin and subcutaneous tissue of the incision;

b) deep incisional: AND infection involves deep soft tissue (for example, fascia, muscle) of the incision;

c) organ/space: AND infection involves any part of the anatomy (for example, organs and spaces) other than the incision that was opened or manipulated during a surgical procedure.

SSI type D (SSI-D)

Postoperative patient within 30 days following a surgical procedure;

AND

diagnosis of an SSI is made by the surgeon or attending physician or designee.

Pneumonia (PNM)

Microbiologically-confirmed PNM (PNM-A)

Patient has at least two of the following: fever (>38°C); ***OR*** cough; ***OR*** purulent sputum; ***OR*** tachypnoea (respiratory rate >20 bpm); ***OR*** worsening gas exchange (SpO_2<94% or decrease from baseline of >3%, new or increased need for supplemental O_2); ***OR*** documented auscultation indicative of pneumonia; ***OR*** compatible findings such as “crackles” or “bronchial breath sounds”;

AND

chest X-ray ***OR*** computed tomography (CT) scan suggestive of pneumonia;

AND

microorganisms isolated from any positive microbiology from the respiratory sample (quantitative or non-quantitative, including serology, antigen in urine, etc.);

AND/OR blood culture.

Radiologically-confirmed PNM (PNM-B)

Patient has at least two of the following: fever (>38°C); ***OR*** cough; ***OR*** purulent sputum; ***OR*** tachypnoea (respiratory rate > 20 bpm); ***OR*** worsening gas exchange (SpO_2<94% or decrease from baseline of >3%, new or increased need for supplemental O_2); ***OR*** documented auscultation indicative of pneumonia; ***OR*** compatible findings such as “crackles” or “bronchial breath sounds”;

AND

chest X-ray ***OR*** CT scan suggestive of pneumonia.

Clinical PNM (PNM-C)

Patient has at least three of the following: fever (>38^{O}C); ***OR*** cough; ***OR*** purulent sputum; ***OR*** tachypnoea (respiratory rate > 20 bpm); ***OR*** worsening gas exchange (SpO_2<94% or decrease from baseline of >3% or new or increased need for supplemental O_2); ***OR*** documented auscultation indicative of pneumonia; ***OR*** compatible findings such as “crackles” or “bronchial breath sounds”.

Ventilator-associated pneumonia (VAP)

PNM-A ***OR*** PNM-B ***OR*** PNM-C;

AND

mechanical ventilation/intubation in place ≤ 2 days prior to first meeting a component of the pneumonia definition.

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World Health Organization
20 Avenue Appia
1211 Geneva 27
Switzerland

https://www.who.int/teams/integrated-health-services/infection-prevention-control

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