

MAURITIUS

National Surveillance Plan on Hospital- Acquired Infections

Ministry of Health and Wellness



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Approval Form

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NATIONAL SURVEILLANCE PLAN ON HOSPITAL-ACQUIRED INFECTIONS			
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The work of Dr. M. Dowlut in developing an electronic questionnaire based on information found in this plan and in carrying out literature reviews is acknowledged.

PEER REVIEW

The support, comments and insight of our regional IPC teams are appreciated.

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Introduction

Hospital-acquired infections (HAIs), also known as nosocomial infections, are a major public health concern due to their association with increased morbidity, prolonged hospital stays, high treatment costs, and elevated mortality rates. In Mauritius, published research has demonstrated that the incidence of HAIs has significantly increased over the past few decades, reaching a value of 18 per 100 admitted patients, with rates in intensive care units (ICUs) as high as 44 per 100 patients.¹ The most prevalent HAI identified was ventilator-associated pneumonia (VAP), with an incidence of 63 per 100 intubated patients and 46 per 1,000 ventilator-days.

The burden of HAIs is further compounded by high levels of antimicrobial resistance (AMR), with local studies reporting alarming levels of carbapenem-resistant organisms such as *Acinetobacter baumannii* and *Klebsiella pneumoniae*.²

The absence of a national surveillance framework for HAIs undermines efforts to improve patient safety and combat AMR. This document elaborates on the steps to be followed to set up a national surveillance system for HAIs in Mauritius.

The World Health Organization (WHO) has clearly outlined the importance of HAI surveillance in its Minimum Requirements for Infection Prevention and Control (IPC) in healthcare facilities.³ These standards mandate that all hospitals should establish HAI surveillance systems as part of their core IPC programs.

Additionally, the WHO Global Action Plan on IPC sets specific targets like:

- To increase the proportion of countries with a national surveillance system for HAIs and related AMR to > 80% by 2030, and
- To develop a national strategic plan for surveillance of HAIs and related AMR by 2026.⁴

It is further highlighted that, following a visit of local public healthcare facilities in 2024, WHO recommended the development of “a national strategic plan for HAI surveillance (with a focus on priority infections based on the local context) and IPC monitoring”.⁷

For health systems with limited resources—such as in low- and middle-income countries—IPC remains one of the most cost-effective health investments. WHO estimates that every dollar spent on hand hygiene and basic IPC measures can result in a return of more than ten-fold in savings from reduced infection rates, shorter hospital stays and decreased antimicrobial use. Moreover, up to 70% of hospital-acquired infections can be prevented through the implementation of effective IPC interventions.⁶

In the context of Mauritius, where local data have shown both high incidence and high mortality from HAIs, as well as elevated levels of AMR, prioritizing IPC interventions and national surveillance is both a strategic and economically sound choice.

This National Surveillance Plan for HAIs in Mauritius is thus an essential component of the country's commitment to safer, more resilient health systems. By systematically capturing, analyzing, and using HAI data, Mauritius will be better positioned to reduce the burden of healthcare-associated infections, strengthen IPC programs, improve patient outcomes, and contain the threat of AMR.

Key Objectives

In line with WHO's and the Ministry of Health and Wellness' (MOHW) priorities, the establishment of a national surveillance system for HAIs in Mauritius aims to:⁵

- Describe the frequency of HAIs: Accurately estimate the prevalence and incidence of HAIs in different healthcare settings.
- Evaluate IPC impact: Assess the effectiveness of IPC programs and interventions over time using robust, measurable indicators.
- Support antimicrobial stewardship: Provide essential information to guide the prudent use of antibiotics and reduce the selection pressure for resistant organisms.
- Inform IPC interventions: Generate data to guide the development and tailoring of targeted, evidence-based IPC measures and policies.
- Benchmark facility performance: Compare HAI rates across facilities and units to support continuous quality improvement and accountability.
- Serve as a quality and safety indicator: Use HAI surveillance metrics as indicators of overall healthcare quality and patient safety.
- Identify trends and high-risk populations: Detect time-bound trends in HAI occurrence and pinpoint vulnerable patient groups and high-risk medical procedures.
- Characterize pathogens: Determine the microbial causes of HAIs and their antimicrobial resistance profiles to support laboratory-based surveillance and response planning.
- Detect clusters and outbreaks: Facilitate early detection and timely response to localized outbreaks and unusual infection patterns.

Timeline for Development of this Plan

- December 2022: The National IPC Committee (NIC) agreed that a national surveillance for surgical site infections (SSI) should be undertaken.
- April 2023: The National IPC Focal Point (NIFP) noted that due to a lack of human resource and because of the poor quality of data during the national studies of 2021 and 2022, in order to conduct a better survey in a timely manner, WHO's assistance should be requested to support HAI surveillance. MOHW acquiesced and the WHO Country Office was contacted with a concept note and a term of reference for a consultant.
- October 2023: Approval of the National Ethics Committee was sought to carry out surveys on HAIs in hospitals.
- December 2023: The National Ethics Committee provided its approval. A local consultant was recruited by WHO but she 'left' within a month.
- July 2024: Dr. M. Dowlut's (IPC Registered Medical Officer at Jawaharlal Nehru Hospital (JNH)) aid was enlisted to (a) carry out a literature review on HAI surveillance systems and (b) develop an electronic form to collect data on HAIs, under the guidance of the NIFP, who is also an Infectious Diseases Specialist. The latter was already trained in the National Healthcare Safety Network's (NHSN) (from the USA Centers for Disease Control and Prevention (CDC)) methodology – however, it had to be adapted to the local context.
- August 2024: A Google Form for four HAIs were created (for VAP, central-line associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI) and SSI).
- September 2024: The form was reviewed by the NIFP, and a testing phase was begun at JNH.
- October 2024: A section on neonatal sepsis was added to the form after a literature review was conducted. A training session for IPC teams was held and the methodology for the survey was detailed. The WHO manual on HAI was released internationally and reviewed locally – due to striking similarities with the methodology proposed in this document, no major changes were made. Some minor modifications were incorporated to improve alignment with WHO's approach.
- November-December 2024: A pilot project was started in the five regional hospitals (of the public sector) of Mauritius.
- January 2025: A small validation team consisting of the NIFP with Dr. Dowlut was created, and collected data was reviewed.
- February 2025: Feedback was provided to all IPC teams regarding the quality of data and improvements to the form were suggested. The methodology was thereafter improved based on suggestions received.
- March 2025: The national HAI surveillance study was carried out.
- April 2025: Quality of the data was reviewed by a national team.
- July 2025: A data analytic tool was developed using Visual Basic for Applications (VBA).

- August 2025: The guide on HAI from the East, Central and Southern Africa Health Community was appraised – it was quite similar to the one from WHO.⁵⁰ Subsequently, this HAI surveillance plan was written and forwarded to IPC teams for their comments. The updated plan was thereafter submitted to MOHW for endorsement.

Roles, Responsibilities, Governance Structure and Coordination

Mauritius is a small island developing state with limited human resources and a centrally managed, government-funded public health system that provides free healthcare services to the entire population. As a majority of the population relies on public health services, it is not cost-effective—nor operationally feasible—to over-decentralize complex programs. Instead, a significant proportion of implementation and operational responsibilities fall under the direct purview of MOHW.

This centralization enables the pooling of limited expertise, standardization of practices, and more efficient resource allocation. However, it also requires that national plans and governance structures be developed with this context in mind. Surveillance protocols, data management tools, training, and monitoring systems are therefore coordinated at national level and delivered in a way that accommodates both the resource constraints and the service delivery model of the Mauritian health system.

The success of the country's surveillance system for HAIs depends on the coordinated contributions of various stakeholders at national and facility levels. Each actor has a distinct but complementary role to play in ensuring the collection of high-quality data, validation, analysis, and translation of surveillance findings into effective IPC action.

1. Upper management of MOHW

The upper management of the Ministry provides the institutional and financial foundation needed to sustain HAI surveillance. Its responsibilities include:

- Approving surveillance-related projects and protocols in a timely manner,
- Ensuring the availability of resources, including personnel, IT infrastructure, and laboratory capacity,
- Supporting the integration of HAI surveillance into national health and AMR strategies, and
- Facilitating intersectoral collaboration and international reporting where necessary.

2. NIC

The NIC, which is part of the national IPC program governance structure, is responsible for:

- Monitoring the implementation of the national HAI surveillance plan across all levels of the health system,
- Reviewing progress reports and performance indicators submitted by the NIFP and the IPC Writing Committee (IWC),
- Advising on strategic and policy directions for the national IPC and HAI surveillance programs,
- Overseeing the implementation of the HAI surveillance plan, and
- Advocating for the integration of HAI data into national health policies.

3. Laboratory services

Microbiology laboratories are a critical component of the HAI surveillance system, as accurate pathogen detection and antimicrobial susceptibility testing form the foundation of data reliability. Laboratories participating in the surveillance system are responsible for:

- Processing clinical specimens in a timely and standardized manner according to national and international quality standards,
- Performing identification of pathogens responsible for HAIs, using validated methods,
- Conducting antimicrobial susceptibility testing following recognized protocols,
- Promptly communicating results to hospitals to support diagnosis and case confirmation, and
- Collaborating with IPC teams to assist data validation and epidemiological analysis.

4. Hospital management

Hospital leadership plays an enabling role in supporting effective surveillance. Responsibilities include:

- Ensuring good quality of patient documentation in medical charts to facilitate case ascertainment,
- Guaranteeing timely access to laboratory results and medical records for accurate HAI diagnosis,
- Supporting IPC teams by allocating staff time and access to records and systems, and
- Promoting a culture of safety and accountability in infection control practices.

5. IWC

The IWC, under the leadership of the NIFP, acts as the technical multidisciplinary team responsible for:

- Providing technical assistance to hospitals participating in the HAI surveillance system,
- Organizing training programs and refresher courses for IPC teams,
- Conducting data validation, quality assurance, and feedback loops,
- Monitoring and evaluating the quality and consistency of reported HAI data,
- Performing data analysis and interpretation to inform IPC policies and practices,
- Writing and disseminating regular surveillance reports, and
- Organizing periodic feedback meetings and facilitating knowledge sharing between hospitals.

6. NIFP

The NIFP serves as the national lead for HAI surveillance and chairs the IPC Writing Committee (IWC), which also functions as the National HAI Surveillance Technical Committee. The NIFP is responsible for:

- Leading the development and revision of national surveillance protocols, definitions, and tools,
- Coordinating with key stakeholders, including hospital IPC teams, laboratory focal points, and Ministry leadership, and

- Ensuring alignment of HAI surveillance with broader IPC and AMR strategies.

7. IPC Teams

Hospital IPC teams are essential to the day-to-day functioning of the surveillance system. Their responsibilities include:

- Collecting high-quality HAI surveillance data using standardized definitions and protocols,
- Ensuring timely reporting of data to the IWC,
- Conducting on-site case validation, liaising with clinicians, and coordinating with laboratories for test results,
- Supporting implementation of IPC interventions based on surveillance findings, and
- Participating in feedback and training sessions as planned by the IWC.

Current Limitations

Effective HAI surveillance relies on accurate clinical data, laboratory support, specialized personnel, and a strong digital backbone. While it is acknowledged that the Mauritian healthcare system has multiple strengths, several systemic challenges also currently limit the quality and reliability of HAI surveillance in Mauritius. These limitations must be recognized and addressed to ensure the successful implementation and sustainability of the national HAI surveillance plan.

1. Human resource gaps

There is a shortage of key personnel required to design, manage, and maintain a robust surveillance system. In particular:

- Healthcare epidemiologists are scarce in the healthcare system,
- There is an insufficient number of medical microbiologists, with existing professionals overburdened by routine diagnostics,
- The country lacks an adequate pool of infectious disease specialists to validate cases, advise on interpretation of data, and lead hospital-based IPC efforts, and
- There are too few medical statisticians, data managers, and IT experts, who are essential to analyse large datasets, ensure data integrity, and support real-time digital platforms.

Without these competencies, the surveillance system risks becoming fragmented, slow, and overly reliant on manual processes that compromise data quality.

2. Clinical documentation

Surveillance systems depend heavily on accurate, timely, and complete documentation in patient medical charts. However, several issues undermine this requirement in Mauritius:

- Inadequate documentation practices or disorganized and misplaced charts mean that the type, onset, and progression of symptoms are often missing or unclear, making it difficult to apply case definitions accurately.
- According to a pilot project that was carried out in December 2024, more than 90% of patient files lack a documented diagnosis (particularly for HAIs).
- Due to medicolegal concerns, healthcare staff are reluctant to record HAIs explicitly in the medical notes, leading to underreporting and loss of critical information.
- As per hospital staff, vital signs—essential for detecting early infection—may be charted inaccurately, further reducing the reliability of clinical indicators.

3. Laboratory

Microbiological confirmation is essential for accurate case classification. However:

- Culture results can remain unavailable, sometimes because samples were not collected despite medical orders.
- Delays in result availability are common, often exceeding the timeframe needed for meaningful clinical action.

- Repeated follow-ups with laboratory staff by phone to trace pending results can be a source of frustration for both laboratory personnel and hospital clinicians.

4. Digital infrastructure

The absence of integrated digital systems significantly impairs the efficiency and scalability of HAI surveillance:

- There is no national Laboratory Information Management System, making the linkage between clinical and laboratory data labour-intensive and error prone.
- The E-Health system is not yet operational, preventing automated alerts, standardized data entry, and real-time analytics.
- Data reporting and transmission still depend heavily on paper forms—methods that are inefficient, insecure, and unsustainable.

Surveillance Methodology

Passive surveillance of HAIs is not a viable option in the context of Mauritius, as it is unlikely that treating doctors will consistently report HAIs in a systematic and standardized manner. This underreporting compromises the accuracy, completeness, and timeliness of the data, which are critical for effective IPC. Therefore, Mauritius has opted to implement active surveillance of HAIs. This approach involves designated trained personnel systematically reviewing patient records, microbiology reports, and other relevant data sources to identify and document HAIs. Active surveillance ensures more reliable and comprehensive data collection, which is essential for guiding national strategies to reduce the burden of HAIs and improve patient safety.

It is noted that the scientific community is moving away from the terminology “hospital-acquired” to the term “hospital-onset” because it cannot always be fully ascertained using current definitions that an HAI, especially bloodstream infections, has truly been acquired from a healthcare facility.^{8, 12}

Accurate identification of HAIs during surveillance requires a system that is practical, consistent, objective, repeatable, and delivers reasonable accuracy. For surveillance purposes, particularly in epidemiological studies, the system should ideally achieve a sensitivity above 80% and a specificity above 50%. In practice, sensitivity is often prioritized over specificity to improve the detection of trends, even at the expense of some false positives.

Several proxy indicators were evaluated during HAI surveys in Mauritius to determine their utility in identifying potential HAIs. The findings revealed significant limitations in the simplified methods tested.

1. Pyrexia > 48 hours after admission

Using the onset of fever more than 48 hours after admission as a trigger for HAI detection can be unreliable in our setting due to:

- Inconsistent recording of vital signs by nursing staff, and
- Blunted febrile response in older adults and patients receiving antipyretics, which reduces sensitivity.

Based on 2025 data, the sensitivity was 18% and specificity was 98%. This method may correctly rule out non-infected patients, but it fails to detect the majority of true HAIs.

2. Leukocytosis or leukopenia > 48 hours after admission

This approach also lacks reliability due to several factors:

- Limited repetition of full blood counts after admission in the public sector;
- Non-specificity of white blood cell (WBC) abnormalities, which may reflect non-infectious conditions; and
- Persistence of baseline WBC abnormalities from admission throughout the hospital stay, making new onset difficult to identify.

Based on 2025 data, the sensitivity was 58% and specificity was 87%. While somewhat more sensitive than fever, this method still misses a significant proportion of HAIs and introduces non-infectious noise.

A similar issue is expected when monitoring hospital-onset Systemic Inflammatory Response Syndrome (SIRS).

3. Positive culture obtained > 48 hours after admission⁹⁻¹¹

This method, which is a type of laboratory-based surveillance, has limitations that introduce both false negatives and system manipulation risks:

- Cultures are often not taken before antibiotic initiation in over 85% of cases;¹³
- Cultures may not be taken at all during clinically evident infections; and
- Staff may reduce culture ordering to artificially suppress HAI statistics.

Based on 2025 data the sensitivity was 42% and specificity was 91%. Although reasonably specific, this method lacks sensitivity and is vulnerable to gaming by underreporting.

4. Initiation of antibiotics > 48 hours after admission with > 48-hour antibiotic-free interval

This proxy is particularly ineffective in Mauritius due to:

- Widespread antibiotic use at admission in > 60% of patients, often without a clear indication;¹⁴ and
- Extended antibiotic courses prescribed as prophylaxis in surgical patients even in the absence of infection.

Based on 2025 data, the sensitivity was 0% and specificity was 100%. This method fails to identify most HAIs and is therefore unsuitable as a surveillance tool.

5. Clinical diagnosis recorded by treating physicians or obtained through interviews

Relying on clinicians to document HAIs is problematic because:

- In more than 90% of cases, no diagnosis is written in the chart; and
- Deliberate omission or manipulation of infection diagnoses may occur due to medicolegal concerns, despite the administration of antibiotics.

The expected performance of this measure is a sensitivity of < 10% and a specificity of > 90%. This method offers little utility in HAI detection currently in the public sector of Mauritius.

6. Use of an intricate digital surveillance form

Given the significant limitations of proxy indicators currently available in routine practice, it was determined that a more structured and systematic approach is required. A detailed HAI surveillance form should be used to collect comprehensive clinical, laboratory, and therapeutic data. This form should be designed for electronic processing, allowing for algorithm-based detection of HAIs with greater consistency and reliability.

This digital approach, once implemented, will support centralized surveillance efforts, allow for automatic data extraction and classification, and overcome many of the current human and system-level limitations faced by the healthcare system.

Study Design

The gold standard for HAI surveillance is prospective incidence surveillance, where infections are identified in real-time as they occur during the patient's hospitalization.¹⁵ This method allows for the most accurate assessment of infection risk, time of onset, and patient-level factors, and is essential for calculating robust epidemiological indicators such as incidence density. However, prospective surveillance is resource-intensive, requiring dedicated personnel, consistent access to clinical data, and more advanced data management infrastructure.

Point or period prevalence surveys are more commonly used in practice.⁵ These surveys can be less demanding and can still provide valuable insights into the burden of HAIs, particularly for comparing facilities or evaluating the impact of IPC interventions over time.

However, the accuracy of prevalence surveys in estimating true incidence rates is debated. A study from Dutch hospitals found that point prevalence surveys (PPS) may significantly underestimate HAI incidence, especially for infections with short durations or rapid onset and resolution.¹⁵ This finding underscores the limited utility of PPS for capturing the full spectrum of HAIs, particularly SSIs and device-associated infections.

Although mathematical models such as Rhame & Sudderth's formula have been used to estimate incidence from prevalence, these approximations can lack accuracy due to assumptions about infection duration, distribution, and detection sensitivity.¹⁶ Nevertheless, a Monte Carlo simulation developed by the NIFP demonstrated the reliability of Rhame & Sudderth's formula. Of note, some authors suggest that PPS can underestimate infection rates compared to period prevalence methods.^{17, 20} Moreover, any type of prevalence surveys can be affected by seasonality, provide only a snapshot of infections at a specific point in time and often cannot help to identify outbreaks rapidly.⁵

With decreasing levels of accuracy, HAI detection can be approached in the following ways:

1. Full-period incidence tracking (e.g., for SSIs up to 30 days post-operation) – gold standard;
2. Capturing data throughout the entire hospital stay – more feasible but still labour-intensive;
3. Assessing retrospective data from admission to the day of survey – intermediate approach; and
4. PPS (single day) – least sensitive, more prone to under- or over-estimation: while HAIs can be missed on a single day, the denominator is often reduced also because of the inordinately increased length of stay of HAI patients.

For the sake of comparison, since high quality data has been published in the past in Mauritius (albeit with a small sample size) using method 2 above¹, converting from point prevalence to the corresponding period prevalence may be cautiously considered in some situations. However, if mainly PPS will be carried out regularly in the future, such conversions will not be necessary to help assess the trend.

It is highlighted that some authors have questioned the use of the term "period prevalence", noting that it may ambiguously refer to either (a) repeated point prevalence measurements or (b) the inclusion of both active and cured infections (thus approaching incidence).¹⁸ Others have argued that defining when an infection is "cured" remains highly subjective and may vary between observers.¹⁶

For the sake of this survey, it will be assumed that active infections are defined as the receipt of antimicrobial therapy – assessing the presence of symptoms in the context of poor documentation can be difficult.

Given the above considerations, local experts in Mauritius have agreed to adopt a two-week period prevalence survey approach, in which:

- Only active infections are assessed;
- Each ward is surveyed once, with a trained IPC staff member reviewing medical charts on a single day; and
- The goal is not to include past infections but to provide a snapshot of active HAIs within a constrained time frame.

This is in line with the European Centers for Disease Control (ECDC) methodology whereby each ward is assessed on the same day and all wards in a single hospital were covered in a mean of 11 days.¹⁹

In fact, a pilot project demonstrated that reviewing a single patient chart while completing the HAI surveillance form required between 10 and 30 minutes (i.e., similar to ECDC's 10 minutes⁴⁹). Based on this workload, a staff member working six hours per day and five days per week, can feasibly review between 120 and 360 charts over two weeks.

This approach represents a balanced compromise between epidemiological rigor and resource availability, offering a practical method to begin routine HAI surveillance nationally.

Disease Selection

Some countries conduct targeted HAI surveillance, often focusing on specific procedures such as SSIs following caesarean sections or appendectomies.^{21, 22} While such surveillance can provide detailed insights into specific groups, it remains limited in scope, gender-biased, and not age-neutral.

In response, Mauritius will adopt a more comprehensive surveillance framework. This decision stems from a previous national study¹ which identified VAP, CLABSI, CAUTI, SSI, and bloodstream infections (BSI) as the most common HAIs.

Moreover, neonatal sepsis will be systematically included, in light of both international expert concern and MOHW data showing an elevated rate of neonatal deaths of 8.6 per 1,000 live births²³ (which is higher than the international average of 7 per 1,000 live births for upper middle-income countries²⁴), with HAIs being strongly implicated.

Peripheral line BSI were found to be rare and will not be specifically included initially. Hospital-acquired gastroenteritis including *Clostridioides difficile* colitis was not observed to be a significant issue in Mauritius.¹

Nonetheless, other important HAIs such as decubitus ulcer infections, hospital-acquired pneumonia (including aspiration pneumonia), and hospital-acquired upper respiratory tract infections (e.g., from COVID-19 and influenza) will be considered for inclusion as surveillance capacity expands, to ensure a comprehensive and equitable national infection control strategy.

To simplify the survey and maintain sustainability, risk factors for diseases will not be collected initially and standardized incidence ratios will not be calculated. Since data on antimicrobial resistance are already collected as part of the Global Antimicrobial Resistance and Use Surveillance System (GLASS) and National One Health Antimicrobial Resistance Monitoring (NOHARM), resistance profile will not be part of the survey at first.

Data Collector Selection

Relying solely on infectious disease specialists or other experts to collect HAI data is neither practical nor an efficient use of limited resources.

Past efforts that depended on part-time data collectors, such as Registered Medical Officers working under the guidance of specialists, failed to yield complete and accurate data due to competing clinical responsibilities and lack of dedicated focus.

Therefore, MOHW recognizes the need to shift towards a more sustainable and effective model by utilizing full-time IPC staff, who are now available across hospitals. These staff members will be trained in standardized surveillance methods to ensure consistent, accurate, and timely data collection, under the guidance of the IPC Team Leaders.

In anticipation of broader Wi-Fi access in hospitals, approval has been obtained to provide internet allowances to data collectors to facilitate timely data entry.

Sampling

Using an online statistical tool available at <https://www.openepi.com/Menu/>, assuming 4,622 inpatient beds are available in the country²³, an expected prevalence of 15% ± 5% of HAI, a design effect of 1 (i.e., a simple random selection, which is not reflective of reality given clustering of HAIs within hospitals) and a 95% confidence interval, the sample size should be 188.

This indicates that including at least 40 patients per hospital in the survey—aligned with the ECDC recommendation of 50—would ensure sufficient statistical power if five hospitals are surveyed. However, to enhance robustness and based on available resources, a minimum of 100 patients per hospital will be included. In hospitals with fewer than 100 beds, all beds will have to be included.

To ensure the inclusion of high-risk groups, all vulnerable patient populations, such as those admitted to Intensive Care Units and Neonatal ICUs, will be surveyed. Surgical wards, including at least one each from general surgery, orthopaedics, and obstetrics-gynaecology (whenever these services are present in the hospital), will also be part of the survey.

The surveillance will cover both tertiary and secondary-level hospitals, beginning with the five regional hospitals in the first few years and gradually expanding to peripheral hospitals. Initially, the survey will be conducted in the public sector only, with the potential for future inclusion of the private sector, depending on resource availability.

Patients will be assigned to the ward where they are located at 9:00 a.m. on the day of data collection, and no patient will be counted more than once across wards.

The minimum frequency of the survey will be once a year with the aim of making it more frequent in the future.

Given the lack of national regulatory definitions, the following classification will be used:¹⁹

- ICU: Wards that take care of intubated patients most of the time.
- Hospital: Any center that has all the following:
 - At least one nursing officer working on site 24 hours a day,
 - At least one doctor working on site 24 hours a day, and
 - Takes care of at least one admitted patient for a minimum of 24 hours a day.
- Primary level hospitals - hospitals that have all of the following:
 - An Accident and Emergency unit,
 - A radiology unit that can do plain x-rays,
 - A lab that can at least do basic tests like hematology and biochemistry,
 - Internal medicine unit,
 - Obstetrics–gynaecology unit, and
 - General surgery unit.

- Secondary level hospitals - hospitals that have all the facilities of a primary level hospital as well as at least five of the following specialties:
 - Neurology,
 - Psychiatry,
 - Ear, Nose and Throat unit,
 - Urology,
 - Critical care unit or ICU,
 - High dependency unit or stepdown unit,
 - Orthopaedics,
 - Ophthalmology,
 - Dermatology,
 - Cardiology,
 - Gastroenterology,
 - Pulmonology,
 - Endocrinology,
 - Nephrology (with dialysis services),
 - Geriatric medicine,
 - Haematology-oncology,
 - Level 2 to 5 trauma centers,
 - Intermediate-level laboratory services (microbiology, histopathology, blood cross-matching or cytology), and / or
 - Intermediate-level radiological imaging using CT or MRI.
- Tertiary level hospitals - hospitals that qualify as secondary level hospitals as well as have at least two of the following departments:
 - Cardiothoracic surgery,
 - Burns unit,
 - Transplant unit (including bone marrow transplant),
 - Neurosurgery,
 - Plastic and reconstructive surgery,
 - Level 1 trauma center,
 - Neonatal ICU,
 - Interventional radiology,

- Spine surgery,
 - Stroke unit,
 - Specialized rehabilitation center,
 - Interventional cardiology,
 - Infectious disease unit,
 - Specialized psychiatric ward (e.g., autism ward),
 - Pediatric surgery,
 - Advanced laboratory services like biosafety lab level 3 or 4, molecular genomics, diagnostic electron microscopy or cell-based therapy / diagnostics, and / or
 - Advanced radiological imagery like PET, SPECT or nuclear medicine scans.
- Specialized hospitals – hospitals that cater for a single clinical specialty, possibly with sub-specialties.
 - Small community hospitals – hospitals that do not fit all the criteria of a primary care hospital or a specialized hospital.

Not all hospitals require an Accident and Emergency unit since in some countries, certain specialized healthcare centers do not admit acute emergencies while others see elective cases only. Of note, some international centers define in-patient care to be admission for at least 48 hours whereas admissions from 24 to 48 hours represent patient observations only.

The following types of hospitals are not defined in this document: quaternary hospitals, rural emergency hospitals, cottage hospitals, university hospitals, prison hospitals, critical access hospitals, long-term acute care hospitals and rehabilitation hospitals.

Specialized hospitals can be of any type e.g., psychiatric, ophthalmological, etc.

It is acknowledged that the deliberate inclusion of high-risk hospitals and high-risk wards may introduce selection bias, potentially resulting in an overestimation of HAI prevalence.

Data Collection and Management

Manual data entry for HAI surveillance was ruled out due to limited human resources, low efficiency, and the additional time required for subsequent data transcription.

The options considered were as follows under the implication that a system had to be developed at no cost:

1. Using ECDC's Hospitals in Europe Link for Infection Control through Surveillance (HELICS) or France's Enquête de Prévalence des Infections Associées Aux Soins (PrevIAS) platforms:^{25, 26}
 - a. Both rely heavily on diagnoses made by treating doctors which, as previously noted, are not consistently accurate in the Mauritian context.
2. Using the US CDC's NHSN systems:
 - a. Through the NHSN portal:²⁷ Access to this system is restricted.
 - b. Using the NHSN checklists:³⁶ Given blunders that commonly occurred (despite brief training sessions) in the surveys of 2021 and 2022, it was recognized that use of these checklists would require a high level of proficiency to be properly filled.
3. Develop a data collection form within the MoBienet app:
 - a. The app lacks the versatility needed for key functions such as pre-entry data validation and handling multiple input formats.
4. Using Microsoft Excel:
 - a. Without ActiveX controls: This was attempted in the past and many users bypassed the data validation criteria which led to poor data quality.
 - b. With ActiveX controls: Very few individuals had the necessary expertise to support this option at no cost; security issues were of concern and due to many platforms disabling macros, portability could be a problem.
5. Using Google Forms:
 - a. This offered a more accessible and user-friendly platform. Collected data can be exported to Excel, and data analysis can then be performed using VBA to ensure proper processing and reporting. Google Forms are also accessible on mobile phones, tablets and laptops, pre-entry data validation is available, and several staff members already know how to use it.

The last option was selected and implemented.

To preserve patient confidentiality, sensitive information like patient names will not be collected – instead, patient initials will be used. Ethical approval from the National Ethics Committee will be requested whenever necessary – it is noted that public health surveillance activities may be exempted from ethics approval according to the rules in some countries.^{29, 30} Moreover, quality improvement studies or audits that do not involve direct patient interactions, are based on the collection of retrospective data, capture de-identified information and do not interfere with standards of care may also not require ethics approval.^{31, 32}

Data will be stored securely on an electronic medium. Data analysis will be carried out using well-recognized software like Excel, R and / or SPSS.

Importance of Standardized Case Definitions

The use of standardized case definitions is essential to ensure objectivity, enable trend analysis, and promote consistency in data collection. Vague definitions of infections were considered unsuitable due to their subjective nature, as they depend largely on diagnoses made by treating physicians.

As a result, the case definitions from the NHSN and ECDC were adopted instead.^{27, 28} These definitions had already been adapted and validated in a previous local study, demonstrating their applicability to the Mauritian healthcare setting.¹ Further details are provided in Annex A.

Quality Assurance

The data validity score (DVS) is a measure of data accuracy and is the mean of the true positivity rate, the true negativity rate and the correct data entry rate. It measures the accuracy of data collection irrespective of how good data documentation is. Table 1 provides an interpretation – usually data with a DVS less than 85% should be rejected for analysis or considered spurious.

Data Validity Score	Quality level
> 95%	Good
85-95%	Acceptable
75-84%	Borderline
< 75%	Poor

Table 1: Interpretation of the data validity score

Ensuring data is accurate is critical for generating reliable and actionable findings. However, previous surveys in the country have highlighted serious deficiencies in data quality. For instance, a 2021 survey on VAP revealed DVS ranging from 24% in one ICU to 73% in another, while a 2022 survey on CLABSI showed DVS ranging from 10% to 61% across different hospitals. These figures are unacceptable and emphasize the urgent need to strengthen data collection practices.

Data validity will be assessed by a team composed of the NIFP, one trained staff member from the hospital being evaluated, and another from a different hospital to ensure objectivity.

Given existing human resource constraints, data validation will be allowed for up to two weeks after data collection, rather than being completed within 24 hours (which is international standard). Additionally, since culture results may not be available at the time of data collection, survey sites will have up to 72 hours post-survey to update laboratory results after the last day of the survey.

To evaluate data quality, 15% of medical records will be randomly selected for review. Medical Records Officers are expected to fully support the retrieval of patient folders as needed. The validation will assess four key dimensions: timeliness, completeness, accuracy, and consistency.

Finally, based on the outcomes of the validation exercise, adjustments to the reported prevalence rates will be made as necessary to better reflect the true burden of HAIs. The formula to be used is as follows (for each healthcare facility and for each HAI type):

$$NTHS = \frac{H MV + HFV}{HFV} * CTHS$$

Where NTHS = New Total number of HAI in the Survey, HMV = number of HAIs Missed by data collectors during Validation, HFV = number of HAIs Found by data collectors during Validation and CTHS = Current Total number of HAI in the Survey. If the formula fails because of 0s, 0.5 will be used as per the Haldane correction.

Pilot project

A pilot survey was conducted to assess and improve the accuracy of the questionnaire being used.

The project included a minimum of 20 patients per health region (for all five regions). After expert validation of a sample of 18 cases—and excluding errors made by data collectors—the case definitions and methodology delineated in this document demonstrated a sensitivity of 100% and a specificity of 90% for identifying HAIs. These results are consistent with WHO's benchmark ranges, which report sensitivities of 80–100% and specificities between 94.9% and 99.7%, depending on the type of HAI.⁵

There was one false positive case, involving a patient with an intracranial haemorrhage who developed fever, leukocytosis and hypoxia more than 48 hours after intubation. Culture results were unfortunately still pending at the time of death. Although he met the criteria for a possible VAP, the expert review panel concluded that the clinical deterioration was most likely due to his neurosurgical complications, not an HAI.

To enhance efficiency during initial screening, the primary trigger question used was the presence of antibiotic use. Other potential triggers—such as the presence of invasive devices or clinical signs and symptoms—were found to be too time-consuming to apply in routine screening. Given the widespread use of antibiotics in the country, it was hypothesized that screening all patients on antibiotics would capture all HAIs. This assumption was confirmed during the pilot, with no HAIs missed using this method. However, this may change in the future if antibiotic abuse diminishes through stewardship interventions.

Overall, the national average for the DVS increased from 42% in 2022 to 69% during the pilot (see Figure 1 for details). Hospitals where greater doctor engagement was observed produced significantly higher quality data. It is hoped that with more experience, our trained staff will improve their data collection process.

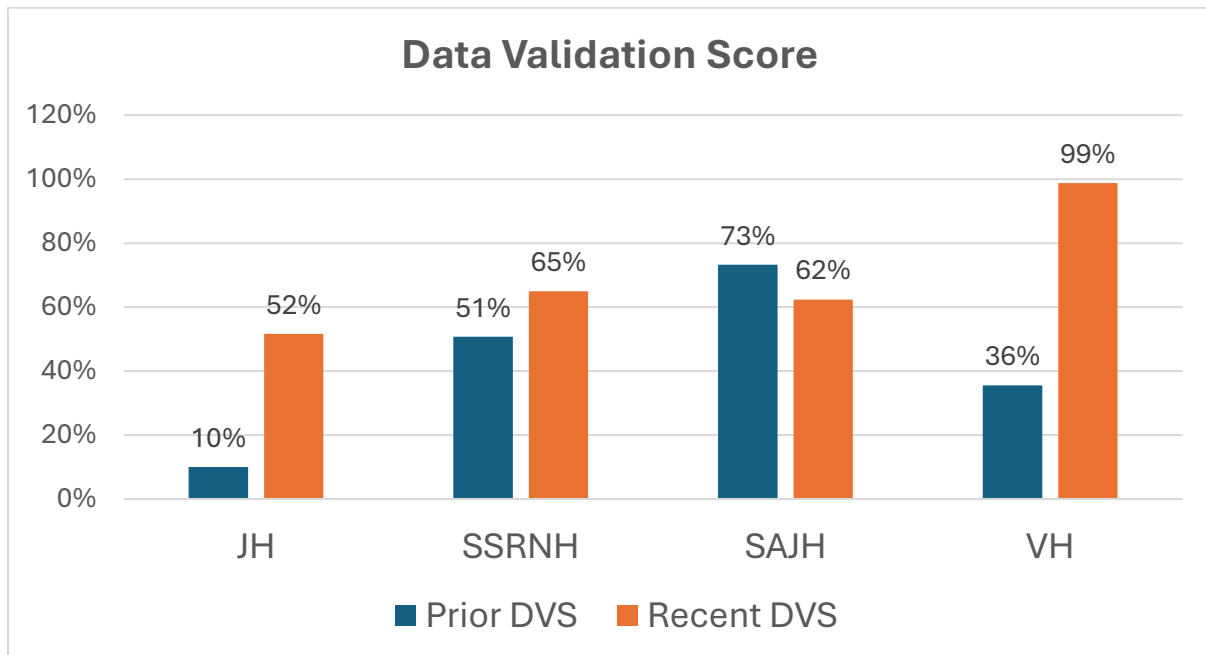


Figure 1: Data from JNH has been excluded since JNH was the center running the pilot project.

Based on feedback received during the pilot, comments were reviewed, and necessary modifications were made to the data collection form to enhance clarity and usability.

Data Analysis and Reporting

Data analysis and reporting will encompass key HAI indicators that have been identified in the National Action Plan on IPC as well as in those in the Monitoring and Evaluation Framework Plan that has yet to be developed.

Prevalence rates will be calculated at both the national and hospital levels, with results further broken down by type of HAI. Trends will be monitored over time to detect any significant changes or patterns.

Where possible, HAI estimates will be stratified by healthcare facility characteristics, such as type of care, facility type, and services offered. If the number of HAIs detected is sufficient, additional disaggregation by age and gender will be conducted to provide deeper insights. Once international benchmarks become available, comparative analysis will also be undertaken. To enhance understanding and communication of results, data visualization tools, including charts and graphs, will be employed.

One area of ongoing discussion is the appropriate denominator for calculating prevalence. As per some international experts, the denominator should only include the population at risk at the time of the survey i.e.:³³

- Only patients admitted for more than 48 hours for overall HAI prevalence,
- Patients with invasive devices in place for over 48 hours for device-associated HAI rates, and
- All surgical patients when calculating SSI rates.

It is noted that other studies may use other criteria, such as including all admitted patients for overall HAI prevalence or all patients with devices, regardless of duration, for device-specific HAIs. However, these studies may also be assessing all sets of infections instead of just HAIs.

Similarly, for calculating incidence rates, the denominator should only contain the number of patients or devices at risk of developing an HAI.

Feedback of surveillance data to healthcare workers through ‘quality circles’ is a key intervention tool.⁵ Effective and timely communication of HAI surveillance data are critical to ensure that the information collected results in tangible actions. Providing facility-specific feedback, accompanied by tailored IPC recommendations, will help identify gaps and challenges, direct efforts to priority areas, and support targeted improvements. Hence, after each survey, a report will be written and disseminated within six weeks of the end of the study.

Feedback will also serve to:

- Improve compliance with surveillance protocols and IPC practices,
- Enhance data quality through clarification and correction where needed,
- Sustain motivation and engagement of healthcare staff, and
- Promote accountability at all levels.

By fostering regular feedback loops, healthcare facilities will be empowered to take ownership of their data, monitor their progress, and implement focused, evidence-based interventions to reduce the burden of HAIs.

Monitoring and Evaluation

The indicators relevant to this document are as follows:

- From 2025 onwards, 100% of regional hospitals will conduct an HAI PPS each year.
- From 2026 onwards, $\geq 50\%$ of specialized, district and community hospitals in the public sector will conduct an HAI PPS each year.
- At least two HAI PPS will be carried out every year in all regional hospitals as from 2027.
- 100% of facilities taking part in the survey will have a DVS $> 85\%$ as from 2027.

Roadmap

Due to current resource and financial limitations, several components will be excluded from the PPS at this stage but may be considered for inclusion in future phases. For example:

- Expanding the scope to cover decubitus ulcer infections, hospital-acquired pneumonia, hospital-acquired upper respiratory tract infections such as COVID-19 and influenza, and peripheral line infections (including arterial lines).
- Monitoring of public health emergencies involving infectious threats.
- Developing an Early Warning and Response (EWAR) system for detecting signals and issuing alerts in the event of HAI outbreaks.
- Incorporating incidence rate calculations to complement prevalence data.
- Identifying risk factors which will help to calculate adjusted Standardized Infection Ratios (SIR) based on national benchmarks.
- Assessing the distribution of multidrug resistant organisms (MDRO) among HAI patients.
- Including the private sector in the surveillance network.
- Increasing the frequency of monitoring to monthly.
- Decentralizing surveillance from a national level to facility level.
- Through adequate training, moving away from the use of complex forms and instead relying on the acquired experience of data collectors and improved chart documentation to identify HAIs; the simplified checklists from Europe and NHSN can then be utilized more widely.
- Once documentation and diagnostic stewardship improve, progressively aligning our definitions with those used internationally (e.g., from WHO, NHSN, and ECDC), following local assessment of their sensitivity and specificity.

These elements are important for building a more comprehensive and responsive HAI surveillance system and will be integrated as capacity and resources allow.

Annex A: List of Standardized Case Definitions

Terms and definitions

- Designations of age groups are as follows:
 - Adults: > 16 years old,
 - Children: 28 days old to 16 years old, and
 - Neonates: 0 day old to 28 days old.
- An HAI is said to be active if the patient is on any systemic antibiotic at the time of the survey and if he / she meets the case definition of an HAI.
- Since patients with device-associated HAIs may have their device removed because of the HAI, data will be collected even if the device was removed within a period extending to 14d before the date of the survey since the patient may still be on an antibiotic for that infection i.e., this would count as an active case. A similar concept applies to neonatal sepsis and SSIs.
- Patients who are not on antibiotics should be included in the survey in order to get a denominator for statistical analysis.
- Age-defined leukocytosis is as follows:
 - > 12,000 cells/ μ L in adults,
 - > 15,000 cells/ μ L in children, and
 - > 20,000 cells/ μ L in neonates.
- It is understood that the above continuum of WBC range can vary depending on studies e.g., for children aged 13-16y, a limit of 12,000 cells/ μ L is often used in some literature.
- Hypotension is defined as a systolic blood pressure < 90 mmHg or whenever a patient is started on inotropes.
 - Low blood pressure has been included as a non-specific criterion for infection so as not to miss cases for whom the WBC was done outside the infection window period and for whom fevers were not rightly charted.
- A commensal is defined as any of the following organisms:³⁷
 - Coagulase negative staphylococci (e.g., *S. epidermidis*, *S. haemolyticus*, *S. hominis*, *S. capitis* or *S. cohnii*),
 - *Micrococcus* spp.,
 - *Propionibacterium acnes*,
 - *Bacillus* spp. (not *B. anthracis*),
 - *Corynebacterium* spp. (not *C. diphtheriae*),
 - Viridans group streptococci,

- *Aerococcus* spp. and
- *Candida* spp. from any site except from sterile areas (i.e., blood, cerebrospinal fluid, deep-seated fluid collection and implanted foreign bodies).
- The day of admission is considered as calendar day 1 (this can also be the date of birth for neonates who are admitted to a hospital).
- The infection window period is 3 days before an event, the day of the event and 3 days after an event.
 - Events can vary depending on the definition of the HAI. Examples include having fevers or developing leukocytosis.
- The culture window period has been extended from 3 days, used by the NHSN, to 7 days, given the prolonged time it takes for cultures to be ordered in the country i.e., 7 days before an event, the date of the event and 7 days after the event.
- The culture and infection window periods cannot start before calendar day 3 of admission or for device-associated HAI, before 48h after device insertion.
- The SSI window period lasts for four weeks in surgeries that do not involve foreign bodies and 90 days in surgeries that involve foreign bodies.
- The neonatal window period starts on calendar day 3 until discharge or calendar day 28, whichever comes first.
- The device window period is from day 3 of device insertion (day 1 is the day of insertion) till 24h after device removal or till discharge, whichever comes first.
- The date of onset of the HAI is the first date when all the criteria in the case definition are met.
- As it is not practical to collect all the data in the patient chart since admission (if the length of stay is longer than several weeks), only data of the last two weeks will be considered relevant during form filling. This is because antibiotic courses for most infections often do not exceed two weeks in the country.
- Repeated HAIs of the same type in the same patient will not be considered for now. Whenever this is captured in the future, a gap of > 14 days should exist in between such repeated HAIs.
- For simplicity, HAIs that occur within 24h after discharge are not captured (if the patient is re-admitted) – this is because data from the patient’s previous folder may not be available.
- Since it is not user-friendly to capture the patient’s daily WBC and temperature in a form, only dates of onset of the anomaly as well the peak or nadir of the anomaly are included. It is presumed that, if an HAI occurs, it will occur within the infection window period of these abnormalities. This does not entirely resolve the problem i.e., HAIs may be missed due to abnormalities that are recorded to be outside the infection window period but actually persisted during the infection window period. A similar issue exists for the presence of hypotension.
- Whenever devices are removed and re-inserted (or exchanged), consider the device to be the same if there is < 24 hours gap in between removal and re-insertion.

- Data on whether patients have been transferred from another facility are not being currently recorded – when collected, HAIs will be attributed to the initial location if they occur within 48 hours of transfer.
 - However, information (like culture results) from the other facility, if available and relevant, should still be captured in the questionnaire.
- Some organisms are, by definition, excluded as causes of HAIs because they occur mostly in the community or have a long latent period – however, for simplicity and because symptoms are usually present on admission anyway, these are not mentioned in the form. Examples are:
 - *Cryptococcus*,
 - *Pneumocystis jirovecii*,
 - Toxoplasmosis,
 - Herpes simplex,
 - Shingles or herpes zoster,
 - Syphilis,
 - Gonorrhea,
 - Tuberculosis,
 - Hepatitis A, B or C, or
 - HIV.
- Microbiologic criteria should ideally include serological tests and molecular techniques like polymerase chain reactions (PCR) but since these are either not routinely performed or they are used to test for mostly community-acquired organisms or results can be delayed, the questionnaire does not include such tests at the moment.
- Similarly histopathologic criteria for infections and foreign body cultures are being ignored since they are rarely performed.
- Whenever data in the patient chart are missing or unclear, data collectors can seek clarifications with (a) the treating doctors, (b) the nursing officers or (c) the patients.
 - However, this complicates data validation by the national team, especially when it is done several days later, due to omissions in the patient chart.
- Culture results are often not available at the time of the survey – data collectors are expected to call the laboratory to get the results after checking with the nurse to confirm that a specimen was actually sent.
 - Call the lab 72 hours after the specimen was despatched.
 - Do not include cultures that were not sent by the nurse in the form.
 - During the pilot project, it was noted that some cultures are sent without any orders being charted in the patient folder – going through the specimen book, if available, can be useful.

- All HAI case definitions apply to children and adults only except for the one for hospital-acquired neonatal sepsis which apply only to neonates.
- Given poor documentation of fevers, all criteria that mention temperature $\geq 38^{\circ}\text{C}$ can be considered met if the patient mentions he / she had fever (in the rare situation where an interview is conducted) or if the doctor has mentioned fever anywhere in the folder.
 - Data collectors should not only go through the patient folder when assessing vital signs i.e., they should examine the nursing vital signs chart also.
- When filling the form, since the most recent episode of a sign or symptom may not be associated with an HAI but another episode of the same sign or symptom a few days prior may fall within the infection window period, it was decided to request for repeated input of data (e.g., up to three times) for certain signs and symptoms (e.g., fever) to increase accuracy. Same applies for culture results and antibiotic treatment. This does not fully resolve the problem since repeated occurrences can happen more often than captured in the form.
- Whenever data collectors are unable to interpret what is written in the patient chart or in a radiology report, help should be sought from a doctor.
- In order to minimize disturbance of clinical work, especially during the rounds of specialists, data collection will typically be carried out in the afternoons.
- The list below outlines the minimum ward types to be included in the form:
 - Adult intensive care unit,
 - Neonatal intensive care unit,
 - Surgical,
 - Medical
 - Orthopaedics,
 - Obstetrics / gynaecology, and
 - Mixed.
- A ward type is considered to be ‘mixed’ if (a) $> 50\%$ of its patients do not fall neatly into a single category or (b) the ward type does not remain stable for a period of at least 30 days e.g., it changes from being ‘medical’ to ‘surgical’ on a weekly basis.
 - If $> 50\%$ of patients are of one type e.g., surgical, then the ward is assigned that particular type.
- If a ward can be classified into several types e.g., it takes in both surgical patients and ICU patients (i.e., surgical ICU), then it should be placed into the category with the highest acuity i.e., adult ICU in this case.
- The following represents the minimum set of organisms that should be captured in the questionnaire:
 - *Acinetobacter* spp.,

- *Klebsiella* spp.,
 - *Escherichia coli*,
 - Coagulase negative staphylococcus,
 - *Enterococcus* spp.
 - *Staphylococcus aureus*,
 - *Pseudomonas* spp., and
 - *Candida* spp.
- The recent taxonomic and nomenclature changes in mycology remain confusing. For the purpose of this survey, the following organisms will continue to be classified as *Candida* spp.⁵¹ Bewildered data collectors can request for additional information from reachable experts if necessary.
 - *Pichia kudriavzevii*,
 - *Nakaseomyces glabrata*,
 - *Meyerozyma guilliermondii*,
 - *Clavispora lusitaniae*, and
 - *Diutina rugosa*.
- An electronic Google Form for data capture is attached separately as a pdf to this document. It is expected that improvements will be made to the form regularly as needed.

Catheter-Associated Urinary Tract Infection (CAUTI)

All of the following should be present for a diagnosis of definitive CAUTI:

1. A urinary catheter is present now and was inserted > 48 hours ago, or was removed < 24h ago
AND
2. At least one of the following occur during the device window period:
 - a. Temperature $\geq 38^{\circ}\text{C}$,
 - b. Temperature $\leq 36^{\circ}\text{C}$,
 - c. Age-defined leukocytosis,
 - d. WBC < 4,000 cells/ μL , or
 - e. Hypotension, AND
3. At least one urine culture within the culture window period is positive for at most two organisms and at least one of these is not a commensal.

Remarks

- Clinical features like suprapubic tenderness, costovertebral angle pain or tenderness, dysuria and polyuria were ignored because they may not be present during a CAUTI and are often not noted in the patient folder.
- Urine cultures that are reported as mixed growth are ignored.
- A case definition for possible CAUTI was considered in catheterized patients who had any positive urine culture, but this was later disregarded because all these patients grew commensals or had mixed growth in their urine.
- Testing using urine dipstick is rarely done in the hospital setting in the country.
- Caution should be exercised when using this epidemiological definition – experts suggest it does not detect true urinary tract infections, and it leads to overdiagnosis and over-treatment because findings of systemic inflammation often have other causes while positive urine cultures are incidental findings.³⁴
- Dates of insertion of urinary catheters are often not recorded in patient charts. Data collectors can make use of the following assumptions when entering the dates in decreasing order of priority:
 - Use the date as written in the patient chart,
 - Use the date of surgery if a surgery was carried out,
 - Use the date of intubation if the patient is ventilated,
 - Use the date of admission to ICU if the patient is admitted to the ICU,
 - Use the date given by the nurse or treating doctor,
 - Use the date given by patient, or

- Use the date of admission.
- If it is unclear whether the patient has a urinary catheter or not based on the patient chart, data collectors should follow the following steps in decreasing order of priority:
 - Examine the patient,
 - Ask the nursing officer,
 - Assume a catheter is present if the patient is admitted to the ICU, or
 - Assume a catheter is present if the patient is an adult and underwent a surgery under general anaesthesia during this admission.
 - Local specialists have reported that Foley catheters are often inserted in the Operation Theatre in children, but they are removed on the same day post-operatively.
- Patients who have a urinary catheter while in the community and get admitted with a UTI are considered to have community-acquired CAUTI. However, it is difficult to ascertain the date of insertion and exchanges of these catheters.
 - In principle, these cases may still be healthcare associated since home nurses may have manipulated the catheters.
- Concentration of the organisms should be $\geq 10^5$ cfu/ml but this was not included in the definition since the lab does not always report the concentration and / or will only report organisms if such concentrations are reached.

Central Line Associated Bloodstream Infection (CLABSI)

All of the following should be present for a diagnosis of definitive CLABSI:

1. A central line is present now and was inserted > 48 hours ago, or was removed < 24h ago AND
2. At least one of the following occurs during the device window period:
 - a. Temperature $\geq 38^{\circ}\text{C}$,
 - b. Temperature $\leq 36^{\circ}\text{C}$,
 - c. Age-defined leukocytosis,
 - d. WBC < 4,000 cells/ μL , or
 - e. Hypotension, AND
3. At least one of the following occurs within the culture window period:
 - a. A positive blood culture for a non-commensal or
 - b. ≥ 2 positive blood cultures for a commensal (of the same species when speciated or else of the same genus), AND
4. All cultures other than blood cultures, central line tip cultures and pus cultures taken from central line sites, are not positive for the same organism.

In a patient that does not meet the criteria for definitive CLABSI, all of the following should be present for a diagnosis of possible CLABSI:

1. A central line is present now and was inserted > 48 hours ago, or was removed < 24h ago AND
2. At least one of the following occurs during the device window period:
 - a. Temperature $\geq 38^{\circ}\text{C}$,
 - b. Temperature $\leq 36^{\circ}\text{C}$,
 - c. Age-defined leukocytosis,
 - d. WBC < 4,000 cells/ μL , or
 - e. Hypotension, AND
3. At least one of:
 - a. Chills within the infection window period,
 - b. A positive blood culture within the culture window period for a commensal or a non-commensal,
 - c. A positive central line tip culture within the culture window period for a non-commensal, or
 - d. A positive pus swab culture taken at the site of insertion of the central line within the culture window period for a non-commensal.

Remarks

- For the definition of definitive CLABSI, the absence of the same organism in other cultures was included as one of the criteria since international definitions often require that no other cause for the bacteremia be present.³⁵
- During discussions, local specialists preferred the criteria for catheter-related bloodstream infections (CRBSI) or catheter exit-site infections, but it is known that, despite being more accurate, they are more difficult to monitor. Some criteria for CRBSI were included in the possible CLABSI definition.
- A central line is a vascular infusion device that terminates at or close to the heart or in one of the great vessels. The following are considered great vessels: aorta, pulmonary artery, superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac veins, and common femoral veins.³⁵
 - Arterial lines are therefore not considered central lines.
 - Central lines include central venous catheters, dialysis lines, Port-A-Cath and peripherally inserted central catheters (PICC).
- Data on the site of insertion will not be included at this point.
- If multiple central lines are currently present, record the date of insertion of the first line only since the form does not allow multiple entries for each central line.
 - When lines are consecutively removed and re-inserted at the same site within 24h, then it is considered to be the same line i.e., input the date of insertion of the first line.
 - For lines that are inserted at different sites, or re-inserted more than 24h later, enter the date of insertion of the current line (i.e., ignore previous lines that are no longer present).
- CLABSIs are likely to be missed in institutions that don't send blood cultures and if they do so only after institution of antibiotics. Since two simultaneous blood cultures are often not drawn in septic patients in the public hospitals, it is usually not possible to know whether commensals in blood cultures represent contaminants or not. To mitigate this issue, the case definition of possible CLABSI was developed. Of note, chills are rarely recorded in patient charts.
- Ideally, the negative cultures (criterion 4 for the definition of definitive CLABSI) should have applied only to cultures taken before the onset of the potential CLABSI but this is not practical for data analysis.
- Dates of insertion of central lines may not be recorded in patient charts. Data collectors can make use of the following assumptions when entering the dates in decreasing order of priority:
 - Use the date as written in the patient chart,
 - Use the date given by the nurse or treating doctor,
 - Use the date hemodialysis was started if the patient is on dialysis,
 - Use the date inotropes were started if pressors are in use,
 - Use the date of intubation if the patient is ventilated,
 - Use the date of admission to ICU if the patient is admitted to the ICU, or

- Use the date of admission.
- Patients who have a central line while in the community and get admitted with a CLABSI are usually considered to have hospital-acquired CLABSI since these patients have their lines accessed by healthcare providers, often in healthcare settings e.g., dialysis patients or those on chemotherapy.
 - Such cases are not always being captured in the form to maintain simplicity.

Surgical Site Infection (SSI)

All of the following should be present for a diagnosis of definitive SSI:

1. The patient had a surgery that does not involve a foreign body \leq four weeks ago or he / she had a surgery that involves a foreign body \leq 90 days ago, AND
2. At least one of:
 - a. Purulent discharge from the site of surgery,
 - b. A positive culture for a non-commensal from a swab at the surgical site,
 - c. A drain is inserted because of an abscess around the surgical site, or an abscess is aspirated around the site,
 - d. The incision is deliberately opened by a doctor (e.g., incision and drainage or wound debridement),
 - e. The wound dehisced and was accompanied by at least one of the following:
 - i. Localized pain or tenderness,
 - ii. Localized swelling,
 - iii. Erythema around the site,
 - iv. Heat at the site, or
 - v. Fever \geq 38°C
 - f. A diagnosis of SSI is recorded by a doctor in the patient chart, or
 - g. A radiological imaging study demonstrates the presence of an abscess or phlegmon near the surgical site.

In a patient that does not meet the criteria for definitive SSI, all of the following should be present for a diagnosis of possible SSI:

1. The patient had a surgery that does not involve a foreign body \leq four weeks ago or he / she had a surgery that involves a foreign body \leq 90 days ago, AND
2. At least one of the following occurs during the SSI window period:
 - a. Temperature \geq 38°C,
 - b. Temperature \leq 36°C,
 - c. Age-defined leukocytosis,
 - d. WBC $<$ 4,000 cells/ μ L, or
 - e. Hypotension, AND
3. All cultures taken at sites other than the surgical incision site are negative for non-commensals, AND
4. The patient does not meet criteria for another HAI, AND

5. A new systemic antibiotic has been started more than >24 hours post-operatively and continued for four days or more, AND
6. No other diagnosis of an infection is mentioned in the patient's chart.

Remarks

1. Serosanguineous discharge does not count as purulent discharge.
2. Stitch abscesses that are not treated with antibiotics are not considered SSIs.
3. The mere presence of a drain does not imply an SSI has occurred.
4. Cellulitis alone at the surgical site without the presence of pus or wound dehiscence is not considered an SSI.
5. Cultures taken from drains connected to the surgical site are accepted.
6. The 90-day SSI window period for surgeries involving foreign bodies has been ignored in the questionnaire for the moment to maintain feasibility. However, for future reference, a list of surgeries for 90-day surveillance is provided below:³⁸
 - a. Breast surgery
 - b. Cardiac surgery
 - c. Coronary artery bypass graft with both chest and donor site incision
 - d. Coronary artery bypass graft with chest incision only
 - e. Craniotomy
 - f. Spinal fusion
 - g. Open reduction of fracture
 - h. Herniorrhaphy
 - i. Hip prosthesis
 - j. Knee prosthesis
 - k. Pacemaker surgery
 - l. Peripheral vascular bypass surgery
 - m. Ventricular shunt
7. Given that a patient may have been started on an antibiotic at the end of the four-week SSI period for an SSI while the data collector is capturing him / her outside the four-week period, under the assumption that antimicrobial treatment can extend for two weeks, patients can still be included in the survey for data analysis six weeks after the surgery was carried out.
8. Given that diagnoses of SSI are not written in the patient folder, cultures are not sent in many cases and signs may not be recorded, several definite SSIs can be missed during the survey. Therefore, it was decided to create a case definition for possible SSI that would include the prolonged use of antibiotics and/or the presence of leukocytosis. However, this failed to capture more SSIs mostly because (a) leukocytosis often started pre-operatively or on the day of surgery

and (b) the same antibiotic that was started on the day of surgery was continued for several days i.e., antibiotics were not changed.

9. Since patients can be admitted for an incision and drainage (I&D) or a wound debridement due to an SSI, capturing the I&D as the main surgery would lead to a missed diagnosis of SSI. Hence, if there is a primary surgery that was carried out before the I&D within the SSI window period, all the I&Ds done post-operatively should be ignored – instead the primary surgery should be captured.
10. For patients who have undergone multiple surgeries at the same site in the past few weeks, include only the first surgery in the SSI window period since the form does not allow capturing data for multiple surgeries.
11. For patients who have undergone multiple surgeries at different sites in the past few weeks, include only the surgery that appears to be most likely linked to an SSI, if any. If none appear associated with an SSI, capture data only for the first surgery within the SSI window period (since this surgery has had more chance to be complicated by an SSI).
12. Some patients develop an SSI and then are on intermittent antibiotic courses for several months – such cases will be missed since they fall outside the SSI window period.
13. Given overall poor documentation, if a pus swab is sent for culture, it should be assumed that purulent discharge was present at the surgical site.
14. Tracheostomy and insertion of drains (not for the drainage of abscesses; e.g., chest drains for pneumothoraces) are also considered as surgeries (albeit minor). This is because staff have noted purulent discharges around the site of drains or around tracheostomy sites several times.
15. The depth of surgery is defined as follows:³⁸
 - a. Superficial: involves only skin and subcutaneous tissue of the incision,
 - b. Deep incisional: involves deep soft tissues of the incision (for example, fascial and muscle layers), and
 - c. Organ / visceral / space: involves any part of the body deeper than the fascial/muscle layers that is opened or manipulated during the operative procedure.
16. The classification of surgeries is as follows:³⁸
 - a. Clean (I): An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tracts are not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage. Operative incisional wounds that follow nonpenetrating (blunt) trauma should be included in this category if they meet the criteria. Caesarean sections, non-vaginal hysterectomies and ovarian surgeries can fall in this category.
 - b. Clean-Contaminated (II): Operative wounds in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, operations involving the biliary tract, appendix, vagina, and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered. The following usually falls in this category:

appendicectomy, biliary tree surgery, cholecystectomy, colorectal surgery, small bowel surgery and vaginal hysterectomy.

- c. Contaminated (III): Open, fresh, accidental wounds. In addition, operations with major breaks in sterile technique (e.g., open cardiac massage) or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered including necrotic tissue without evidence of purulent drainage (e.g., dry gangrene) are included in this category.
- d. Dirty or Infected (IV): Includes old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera. This definition suggests that the organisms causing postoperative infection were present in the operative field before the operation.

Ventilator-Associated Pneumonia (VAP)

All of the following should be present for a diagnosis of definitive VAP:

1. The patient is intubated now and was intubated > 48 hours ago, or he / she was removed from the ventilator < 24h ago AND
2. At least one of the following occurs during the device window period:
 - a. Temperature $\geq 38^{\circ}\text{C}$,
 - b. Temperature $\leq 36^{\circ}\text{C}$,
 - c. Age-defined leukocytosis,
 - d. WBC < 4,000 cells/ μL , or
 - e. Hypotension, AND
3. At least one of the following occurs within the infection window period and is of new onset or worsening:
 - a. At least one chest x-ray or pulmonary CT scan is consistent with pneumonia,
 - b. New onset or worsening hypoxia as defined by:
 - i. A drop of oxygen saturation by $\geq 3\%$ in SpO_2 for the same FiO_2 within a 24h period,
 - ii. An $\text{SpO}_2 < 94\%$ if initially not hypoxic,
 - iii. A rise in FiO_2 requirement by $\geq 20\%$ within a 24h period, or
 - iv. An increase in PEEP by $\geq 3 \text{ cmH}_2\text{O}$ within a 24h period.
 - c. Dyspnoea or age-defined tachypnoea,
 - d. Crackles / crepitations, rales, rhonchi or bronchial sounds on physical examination,
 - e. New onset of purulent sputum, change in character of sputum, increased respiratory secretions, or increased suctioning requirements,
 - f. Cough, or
 - g. For children, apart from the above, the patient can also have, apnoea, nasal flaring, retraction of chest wall or grunting, AND
4. No diagnosis of pneumonia was written in the chart at the time of intubation, AND
5. At least one of the following occurs within the culture window period:
 - a. An endotracheal aspirate, endotracheal tip, bronchoalveolar lavage, sputum or pleural fluid culture is positive for a non-commensal, or
 - b. A urine antigen test is positive for *Legionella* spp. or *Streptococcus pneumoniae*, or
 - c. A PCR test on endotracheal secretions, throat swab, or nasopharyngeal swab is positive for an organism that is a non-commensal.

In a patient that does not meet the criteria for definitive VAP, all of the following should be present for a diagnosis of possible VAP:

1. The above criteria 1, 2 and 4 for definitive VAP hold true AND
2. At least one of the following occurs:
 - a. Criterion 3 is true, or
 - b. Any respiratory sample sent for culture is positive (for a commensal or a non-commensal).

Remarks

1. Age-defined tachypnoea is as follows:³⁹
 - a. 28 days old to 12 months old: > 60 breaths / min
 - b. > 12 months old to 3 years old: > 40 breaths / min
 - c. > 3 years old to 12 years old: > 30 breaths / min
 - d. > 12 years old: > 20 breaths / min
2. NHSN criteria were followed to the extent possible but considerable simplifications had to be applied.⁴⁰ For instance:
 - a. Given that chest x-ray imaging may not be repeated, or results / films may not be available, two images are not needed for a diagnosis, even in patients with underlying cardiac or pulmonary disease.
 - b. Evolution of infiltrates or other radiological findings are ignored since such assessments are difficult in the absence of an electronic Picture Archiving and Communication System (PACS).
 - c. Bradycardia or tachycardia is considered too non-specific for a diagnosis of VAP.
 - d. Semi-quantitative or quantitative cultures or quantification of WBC in respiratory samples are often not reported and hence, are ignored as part of the criteria.
 - e. Confusion in patients above 70y old is not being considered because this is non-specific in intubated patients.
 - f. Due to difficulties accessing and visualizing x-rays during chart review, pulmonary imaging is no longer a mandatory criterion for the diagnosis of pneumonia – this is in line with WHO's case definition of clinical pneumonia (PNM-C).⁵
3. FiO₂ and peak end-expiratory pressure (PEEP) are often not recorded at regular intervals and usually cannot be relied upon to make a diagnosis of VAP in the country.
 - a. This means that knowing which FiO₂ or PEEP was maintained for at least one hour and which one was the minimum for the day is usually unclear i.e., such details, while used to define ventilator-associated events, will be ignored.⁵²

4. Due to poor documentation, it is often not possible to know which signs and symptoms are actually worsening – hence, it was decided to ignore all VAP that may occur in patients who had pneumonia initially. If a diagnosis on the day of intubation is not available, the diagnosis at admission is considered.
5. Since cases of VAP may be missed due to signs and symptoms not being written in the chart, it was decided to add a case definition for possible VAP where reliance on culture results is increased.
6. As mentioned previously, urine antigen tests and PCR are not currently included in the questionnaire in order to maintain practicality and because they are not routinely performed on patients in the public sector. It was added to the definition to aid private clinics.
7. Data collectors who are unable to interpret chest x-rays should discuss imaging studies with the treating doctor and if the latter is unavailable, with the nearest available doctor.
 - a. As plain x-rays on in-patients may not be automatically read by radiologists in public hospitals, interpretations can be more subjective and inconsistent than in institutions where radiologists systematically read all x-rays in a timely manner.

Hospital-Onset Neonatal Sepsis (HO-NEO)

All of the following should be present for a diagnosis of definitive HO-NEO:

1. Two or more of the following are present during the neonatal window period:
 - a. Either one of: temperature $> 38.5^{\circ}\text{C}$ or temperature $< 36^{\circ}\text{C}$,
 - b. Heart rate > 180 bpm,
 - c. Heart rate < 100 bpm,
 - d. Urine output < 1 ml/kg/h (averaged over four hours),
 - e. Age-defined hypotension,
 - f. Apnoeic,
 - g. Respiratory rate > 60 breaths/min,
 - h. On a ventilator (invasive or non-invasive),
 - i. Any one of: FiO_2 increased by $> 20\%$ within 24h, PEEP increased by $> 3\text{cmH}_2\text{O}$ over 24 hours or new onset $\text{SpO}_2 < 90\%$,
 - j. Any one of: irritability, lethargy, or hypotonia,
 - k. Any one of: age-defined abdominal distension, nutritional intolerance, insufficient breast feeding or difficulty sucking,
 - l. Either one of: petechiae or sclerema,
 - m. Either one of: $\text{WBC} < 4,000$ cells/ μL or $\text{WBC} > 20,000$ cells/ μL ,
 - n. Immature to total neutrophil ratio > 0.2 ,
 - o. Platelet count $< 100,000$ cells/ μL ,
 - p. $\text{CRP} > 15$ mg/L,
 - q. Procalcitonin ≥ 2 ng/ml,
 - r. Hyperglycemia at least twice with glucose > 10 mmol/L,
 - s. Hypoglycemia at least twice with glucose < 2.5 mmol/L,
 - t. Either one of: base excess < -10 mEq/L or lactate $> 2\text{mMol/L}$, or
 - u. Age-defined creatinemia, AND
2. At least one of the following is true during the neonatal window period:
 - a. A positive blood culture or cerebrospinal fluid (CSF) culture for a non-commensal or
 - b. ≥ 2 positive blood cultures or ≥ 2 positive CSF cultures for a commensal (of the same species when speciated or else of the same genus).

In a patient that does not meet the criteria for definitive HO-NEO, all of the following should be present for a diagnosis of possible HO-NEO:

1. One of the following criteria apply:
 - a. Four or more of the criteria listed in part (1) of the definition for definite HO-NEO are present,
 - b. Three or more of the criteria listed in part (1) of the definition for definite HO-NEO are present AND any culture taken from the neonate is positive (for a commensal or a non-commensal), or
 - c. A positive blood culture for a non-commensal during the neonatal window period.

Remarks

1. No widely agreed upon criteria exist internationally for the diagnosis of neonatal sepsis due to difficulties to reach consensus (more so among premature babies). However, given the vulnerability of neonates, in view of the elevated neonatal mortality in the country and because of a lack of data on neonates, it was imperative that national case definitions be developed.
 - a. Following a literature review, the European Medicines Agency (EMA) criteria were adopted and contextualized.⁴¹
 - b. Other criteria either lacked supportive evidence, did not include sufficient signs and symptoms or did not have enough reliance on laboratory data.
 - c. Many authors prefer to use solely microbiological criteria to define neonatal sepsis, but this cannot apply in a country where cultures may not be taken or where cultures are taken after the initiation of antibiotics.
 - d. Contrary to some authors, we do not consider sepsis to occur in patients with only positive cultures without corroborating signs and symptoms – this is in line with adult definitions i.e., it is presumed that asymptomatic bacteremia can occur in neonates. However, it does not imply that asymptomatic bacteremia should be left untreated in neonates.
 - e. Furthermore, the presence of commensals in only one blood culture is not sufficient to definitively diagnose sepsis i.e., it is implied that contamination of cultures can and do occur in neonatal ICUs (NICU).
 - f. Some authors require that patients with hospital-acquired neonatal sepsis be on antibiotics and had an invasive procedure (e.g., intravenous cannulation or tracheal intubation) – this is not considered mandatory in the case definition here.
 - g. Other experts claim that case definitions often do not apply to premature babies and prefer to rely on clinical expertise solely, but this is too subjective.
 - h. The Kaiser Permanente Neonatal Sepsis calculator appears to focus only on early sepsis and assesses the risk of developing sepsis instead of diagnosing sepsis.⁴⁵ It can be useful for clinicians who want to use the pre-emptive approach to therapy.
2. Terminologies remain confusing in the neonatal literature: late onset sepsis starts after 72 hours after delivery (or after seven days depending on the literature) but hospital-acquired sepsis

continues to be defined as from 48 hours. Sepsis that occurs within 48 hours of birth is sometimes referred to as being mother-acquired.

3. Calendar day 1 starts on the day of admission; however, for the majority of cases, calendar day 1 is the date of birth.
4. Similar to the issue arising with SSIs, neonates will be included in the survey till six weeks of age so as to capture patients who developed hospital-acquired sepsis within four weeks of life and who started antibiotics late.
5. Modifications were made to the EMA criteria as follows:
 - a. Two clinical / lab criteria are required for neonatal sepsis instead of four because it was noticed that some neonates had positive blood cultures for non-commensals but did not meet all four criteria.
 - b. However, for possible sepsis, four criteria were maintained even though one neonate met three criteria and both the treating doctor and the NIFP considered this baby to be septic. However, cultures turned out to be negative.
 - c. The separation of clinical criteria from laboratory criteria were not maintained because one septic neonate had more signs and not enough laboratory criteria. Therefore, both were merged.
 - d. Blood creatinine level was added because of difficulties to ascertain urine output in the NICU.
 - e. Using age-defined criteria for bradycardia and tachycardia appeared non-practical. International experts set the lower limit as 100 bpm with the upper limit varying from 160-190 bpm.^{42, 43} Local paediatricians agreed on an upper limit of 180 bpm.
6. The infection window period does not apply for neonatal sepsis i.e., all the criteria should be met within the first 28 days of life and after 48 hours of admission.
7. While epidemiological criteria should only be used cautiously for clinical purposes, as a guide for treating doctors, antimicrobial therapy can be started whenever two or more criteria in part (1) are present:
 - a. The treatment should be stopped within 72h as soon as cultures turn out to be negative or adjusted appropriately if cultures are positive. While internationally 48h is used as the limit, this cannot be done currently since results can be delayed.
 - b. If four or more criteria in part (1) are met, treatment should be continued even if cultures are negative. In other words, all babies who meet the diagnosis of possible sepsis should be treated.
 - c. For clinicians who wish to follow the pre-emptive approach, they can use online calculators⁴⁵ and decide to start treatment temporarily despite the absence of any signs of symptoms. However, they need to ensure antibiotics are de-escalated within 48h or else the rate of antimicrobial resistance will likely escalate out of control in the NICU.
8. Apnoea is defined as a pause in breathing for > 20 seconds.

9. The threshold for serum CRP was the object of much debate locally – most national experts preferred to use 5 mg/L. However, the NIFP as well as American neonatologists considered this to be inappropriate and to likely contribute to an abuse of antibiotics through over-diagnosis of sepsis. A literature review revealed that two articles used a threshold of 6 mg/L, 28 articles used a threshold of 10 mg/L and seven articles used a threshold of 20 mg/L. Therefore, EMA’s criterion of 15 mg/L was maintained.
10. Procalcitonin is not available in the NICUs and therefore is not in the questionnaire. Lactate level is occasionally done and has been included.
11. Urine output is measured by weighing the diaper of the baby. An average over four hours should be taken due to hourly variations in output based on hydration status. The weights are subtracted, divided by the number of hours lapsed and further divided by the weight of the baby to get the output in ml/h/kg. Nurses may require the assistance of doctors for such calculations.
12. Hypoxia is defined in neonates as an SpO₂ of less than 90%.⁴⁴
13. Age-defined hypotension was derived from an article by Dilli et al.⁴⁶ However, patients on inotropes are also considered to be hypotensive.

Gestational age of patient at birth (weeks)	Systolic blood pressure (mmHg)
<24	<33
24-28	33-41
29-32	42-48
33-36	50-55
37-40	57-61
>40	61-71

Table 2: Upper limit of systolic blood pressure according to gestational age. From Dilli et al.⁴⁶

14. Age-defined abdominal circumference is given in an article by Setruk et al.⁴⁷ Distension is said to have occurred if the circumference is > 97th percentile for the given gestational age and post-natal age, or if there are radiological signs of distension (like pneumoperitoneum).

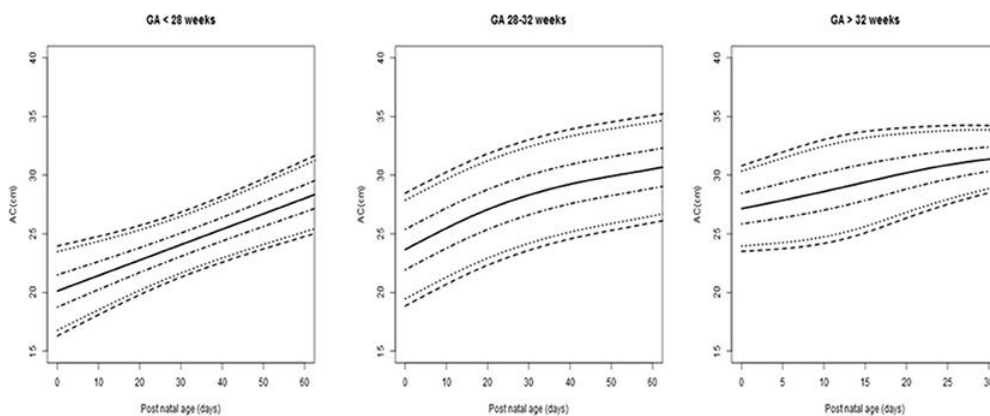


Figure 2: Abdominal circumference (AC) values (cm) for postnatal age (days) according to the different groups of gestational age (GA). Lines are 3rd, 10th, 25th, 50th, 75th, 90th, and 97th centiles. From Setruk et al.⁴⁷

15. Age-defined creatinemia is determined as per the article by Bateman et al.⁴⁸

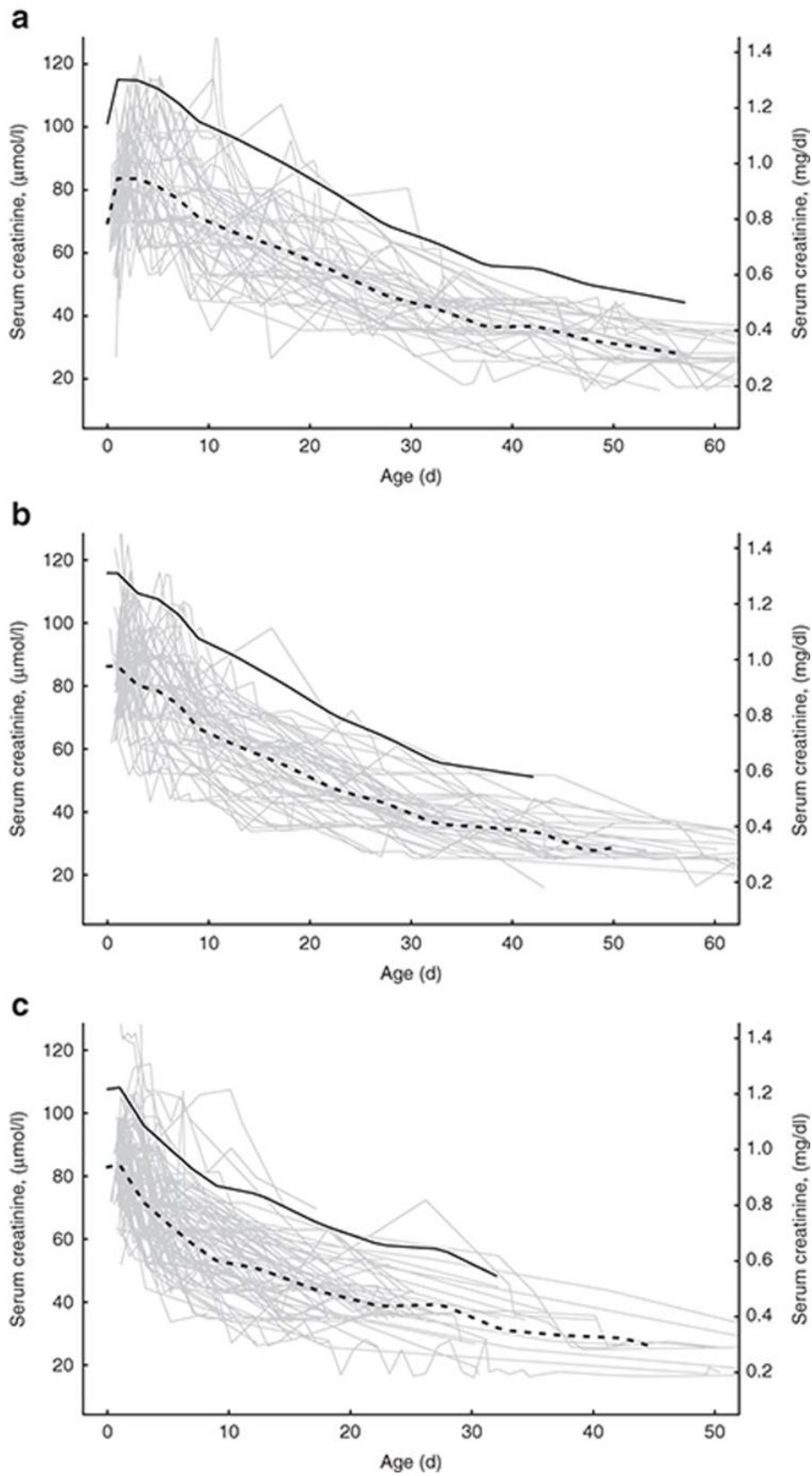


Figure 3: Predicted mean serum creatinine (dashed line) and upper 95th percentile (solid line) for each gestational age (GA) group. The underlying light gray lines depict plots of each study infant. (a) GA group 25–27 wk. (b) GA group 28–29 wk. (c) GA group 30–33 wk.

17. All screening cultures (which are typically swabs from the ears, eyes and / or umbilicus of the neonate) in babies that are asymptomatic at the site of the culture should be ignored.
 - a. Pus cultures from the umbilicus in suspected omphalitis cases should be included.
18. Given the complexity of the patient charts in the NICU, data collectors are encouraged to interact with the treating doctors and nurses to gather high quality data.

Hospital-Onset Bloodstream Infection (HO-BSI)

All of the following should be present for a diagnosis of definitive HO-BSI:

1. At least one of the following on calendar 3 onwards:
 - a. Temperature $\geq 38^{\circ}\text{C}$,
 - b. Temperature $\leq 36^{\circ}\text{C}$,
 - c. Age-defined leukocytosis,
 - d. WBC $< 4,000$ cells/ μL , or
 - e. Hypotension, AND
2. At least one of the following occurs within the culture window period and on calendar day 3 onwards:
 - a. A positive blood culture for a non-commensal or
 - b. ≥ 2 positive blood cultures for a commensal (of the same species when speciated or else of the same genus), AND
3. None of any cultures taken on calendar days 1 and 2 are positive for the same organism as above

Remarks

1. Patients with community-acquired vascular infections like infective endocarditis can have positive blood cultures for several days after admission; criterion 3 helps to ignore such cases.
2. For the sake of exclusivity during data analysis, if the patient also does not meet criteria for a CLABSI (i.e., he / she additionally did not have a central line inserted three days or more in the past or a central line was not removed 24 hours or less ago), then the patient is said to meet the definition of HO-BSI-NCL.
3. The presence of chills has been ignored because it is often not charted.
4. Leukocytosis was added to the definition because fevers may not be charted, or temperature may only be recorded after antipyretics are administered.
5. Some patients may meet the definition for possible CLABSI e.g., by having a single commensal in the blood culture, but will not meet the criteria for HO-BSI since the latter requires two cultures with non-commensals (since it is a definitive diagnosis).

Hospital-Onset Suspected Unidentified Systemic Infection (HO-SUSI)

All of the following should be present for a diagnosis of HO-SUSI:

1. At least one of the following on calendar 3 onwards:
 - a. Temperature $\geq 38^{\circ}\text{C}$,
 - b. Temperature $\leq 36^{\circ}\text{C}$,
 - c. Age-defined leukocytosis,
 - d. WBC $< 4,000$ cells/ μL , or
 - e. Hypotension, AND
2. A new systemic antibiotic is started on calendar 3 or later AND
3. The new systemic antibiotic is continued for 4 days or longer AND
4. The patient is not diagnosed with any other hospital-acquired infections

Remarks

1. This definition was created to catch missed SSIs (e.g., in patients who underwent a surgery, was started on a prolonged course of an antibiotic and for whom no culture was sent, and signs of infection were not recorded) and other HAIs (like hospital-acquired pneumonia).
2. This definition may lead to an overdiagnosis of HAIs since it is common practice in the country to keep patients with ‘rumbling’ infections (e.g., septic foot ulcers) admitted for prolonged periods, switch antibiotics regularly, and eventually perform surgery when medical treatment fails.
 - a. Even then, some might consider such cases to be hospital-acquired in the sense that these patients often develop infections from MDROs which are usually transmitted in the healthcare facility.
 - b. Since outpatient parenteral antimicrobial therapy (OPAT) is still not commonly practised in the country, admitting patients for extended courses of antibiotic is routine.
3. Initially, it was agreed to add a microbiological criterion (i.e., any positive culture) but this was later dropped because that definition failed to capture any HAI.
4. It is likely that creating a definition for hospital-onset sepsis using the Sequential Organ Failure Assessment (HO-SOFA) would be clinically more useful, but this is currently not practical in the country.

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