

Surveillance of health care associated infections in low to middle resource countries

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Abstract

Surveillance is an essential component of infection control programmes. Amongst other objectives, its main aim is to identify outbreaks, establish the baseline rate of infections, and ultimately achieve reduction in all preventable health care associated infections (HCAIs) and incidents. Since surveillance is an expensive and time-consuming exercise, it is essential that objectives of the surveillance must be set at the very outset.

Different methods of surveillance exist and the type of surveillance method depends on local factors, i.e. the type and size of hospital, case mix and the availability of local resources. Targeted surveillance aimed at high risk areas, procedure directed or specific type of infections associated with high morbidity and/or mortality is more cost effective and is manageable in various health care settings worldwide. However, a substantial reduction of HCAIs can only be achieved if the outcome surveillance is combined with the process surveillance. Further reduction can be achieved and sustained on a long term basis if the Root Cause Analysis of all preventable HCAIs can be added to the surveillance process.

This paper outlines the methods and requirements, and discusses the challenges faced in setting up an *effective* surveillance programme in low to middle resource countries and suggests practical solutions to overcome some of these issues.

Key words

Infection control+methods; Developing countries; Root cause analysis; Cross infection

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“If you cannot measure it, you cannot improve it.”

Lord William Kelvin

Introduction

The old term ‘nosocomial’ or ‘hospital acquired’ infection is no longer used and the new term ‘Health Care Associated Infections’ (HCAIs) has been adopted instead. This is in response to recognise that the provision of modern medical care is no longer confined to hospitals only but is provided by various health care facilities, including day procedure surgical and medical units (haemodialysis, chemotherapy units etc.), and health care facilities outside the hospital setting.

The global burden of HCAIs remains unknown due to the difficulty in gathering reliable data especially in low to middle income countries. This is because most of these countries lack resources, and basic infrastructures for Infection Prevention and Control (IPC) programmes either do not exist or are not fully functional. As a consequence, proper surveillance of HCAIs is not carried out in most hospitals. Recent systematic review from WHO has estimated that at any time, over 1.4 million people worldwide suffer from HCAIs. About 5-10% of patients admitted to modern hospitals in the developed world acquire one or more infections; the proportion can exceed 25% in low to middle income countries. The risk of HCAI in developing countries is 2 to 20 times higher than in developed countries.¹

It is important to emphasise that the provision of an effective IPC programme should be an integral part of patient safety, and the surveillance of HCAIs is the foundation for organising, implementing, and maintaining such a programme in all health care facilities worldwide. The landmark SENIC study has highlighted that 6% of HCAIs can be prevented using minimal infection control efforts, and 32% could be prevented by a well organised & highly effective infection control programme.²

Definitions

Surveillance has been defined as the systematic collection, analysis, and interpretation of data on specific events/infections and diseases, followed by the dissemination of this information to those who can improve the outcomes.

HCAIs are defined as infections that occur more than 48 hours after admission and within 7-10 days after hospital discharge. The time frame can be modified for infections that have incubation periods less or more than 48–72 hours.³ Surgical site infections (SSIs) are considered HCAIs if the infection occurs within 30 days after the operative procedure or within 1 year if a device or foreign material is implanted.⁴

It is also important to bear in mind that there are no internationally agreed definitions for outcome surveillance. The most commonly used definitions were developed by the CDC/NHSN in the USA⁵ and the ECDC in Europe.⁶ Worldwide, CDC/NHSN definitions with/without modification have been used. Both definitions assume availability of adequate resources and good diagnostic laboratory support which is a major issue, especially in low to middle income countries. A simplified definition of HCAIs is published by the WHO which can be used in low resource countries (see table I)⁷ and can be modified according to the availability of local resources.

Objectives

Since surveillance is an expensive and time-consuming exercise, it is essential that the objectives of the surveillance must be set at the very outset. The main objectives of surveillance can be summarised as follows:^{8,9}

- Investigate problems, and identify and control outbreaks
- Establish endemic/baseline rates of infections as part of a benchmarking exercise which will help prioritise areas so that scarce resources are diverted in high risk area(s)
- Convince and educate clinical team to highlight the problem and encourage them to adopt good IPC practices to improve both outcomes and processes
- Reduce HCAI rates within health care facilities by introducing evidence-based and cost-effective interventions
- Compare HCAI rates within/between health care facilities as part of national requirements and/or quality standards
- Evaluate control measures and reinforce good IPC practice
- Use as research tool

Table 1. Simplified definition of healthcare associated infections

| Infection | Definitions |
|------------------------------------|---|
| Surgical Site Infection | Any purulent discharge, abscess, or spreading cellulitis at the surgical site during the month after the operation |
| Urinary Tract Infection | Positive urine culture (one or two species) with at least 10 ⁵ bacteria/ml with or without clinical symptoms |
| Respiratory Tract Infection | Respiratory symptoms with at least two of the following <ul style="list-style-type: none"> • Signs appearing during hospitalisation • Cough, purulent sputum, new infiltrate on chest • Radiograph consistent with infection |
| Vascular Catheter Infection | Inflammation, lymphangitis or purulent discharge at the insertion site of the catheter |
| Septicaemia | Fever or rigours and at least one positive blood culture |

From *Prevention of hospital acquired infections: A Practical Guide*. 2nd ed. Geneva: World Health Organization, 2002.

Types of surveillance

The standard approach to surveillance is that once the area and/or type of infection is identified, the next decision is which type of surveillance to use i.e. Passive vs Active and Outcome vs Process.

Active vs passive surveillance

Surveillance process can be *active* - with a process for seeking out HCAI cases or *passive* - which is dependent on a third party to fill out a form or chart and send it in to the IPC team for analysis. It is well recognised that reliance on passive surveillance has always been demonstrated to underestimate cases.¹⁰ In addition,

this method not only lacks a standard approach to case finding, but substantial time is required for case ascertainment, data collection and therefore allowing less time and energy to be directed toward intervention in controlling processes to prevent infection in the first place!

Outcome vs Process surveillance

The aim of **outcome surveillance** is to *count* the number of HCAs (Figure 1). In the past, IPC teams and epidemiologists worldwide invested substantial amounts of resources on outcome surveillance (*counting*) and minimal resources in (*controlling*) processes.^{11, 12}

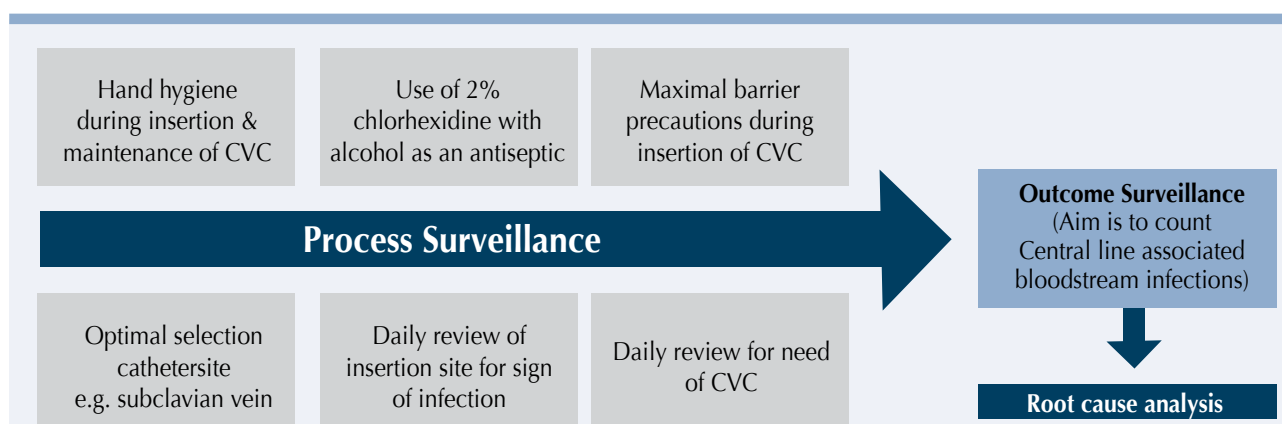


Figure 1. The difference between process and outcome surveillance

Adapted with modifications from Damani NN. *Manual of Infection Prevention and Control*. 3rd edn. Oxford: Oxford University Press, 2012.

One of the major problems with the monitoring of 'outcome' *only* is that it will inform you about the magnitude of the problem but will *not* provide you with information and knowledge regarding what factor(s) might be contributing to the HCAs. In addition, relying only on 'outcome' monitoring includes problems with (i) availability of good quality laboratory support (ii) reliability of data if they are not subject to risk stratification (iii) staff need to be trained to interrupt definitions, and (iv) independent validation of HCAs rate. Current medical advances and change in the delivery of health care have allowed shorter stays in hospital with higher throughput of patients therefore most HCAI will not be identified as they will appear *after* the patient is discharged and this is a major issue which is contributing to unreliability of data generated by the use of outcome surveillance. For example, it has been identified that 72% of coronary artery bypass surgical site infections were identified following discharge in the community.¹³ Therefore to generate any reliable data on the outcome surveillance, a follow up of patients in the community is essential and this is a challenging task even in high resource countries where surveillance programmes have been well established for decades.

The aim of **process surveillance** is to *control* the processes which are leading to HCAs (Fig 1). In recent years, with the introduction of various HCAI 'Care Bundles,' originally developed by the Institute of Health Improvement in the USA,¹⁴ and modified and adopted by the UK Dept. of Health,¹⁵ emphasis is placed on the controlling and monitoring 'processes' and this change in approach has achieved a significant and sustained reduction in HCAs.^{16,17} Berenholtz *et al* has recommended that compliance with all the elements of the bundle should be measured on an 'all' or 'nothing' basis.¹⁸ This is because the temptation to pick only easier elements of the care bundle is too great. Monitoring compliance is important as '*people do what you inspect, not necessarily what you expect*'. One of the main reasons for the success in reduction of HCAs since the introduction of monitoring of processes is that it allows the clinical team to understand the good IPC practices required for the procedure(s) and serves as an educational tool to implement evidence-based practices. In addition, it helps standardise protocols and procedures to avoid variation in practice which

is essential in an area where there is a high turnover of staff.

Although compliance with all elements of the care bundle on all patients at all times is ideal, it can be very difficult to achieve in practice. Furya *et al* have highlighted that if an average ICU were to comply with at least one component of the bundle at all times, they would experience an estimated 38% decrease in their Central Line-Associated Blood Stream Infection (CLA-BSI) rate.¹⁹

However, relying *only* on 'process' monitoring includes problems with the reliability of data as some health care facilities collect data based on review of a few selected patients for each care bundle. In addition, the hospital may have good compliance with all elements of the care bundle but this type of surveillance will not provide you with the information on whether the task was performed correctly or not. Experience has shown that the clinical team might develop a 'tick the box' mentality to filling in the check list for care bundles. This issue can be overcome by analysing the reliability of data and introducing monitoring of compliance with all elements of the care bundle, breaking down the data and feeding back to the individual consultant and/or clinical team to tease out variations. It can be argued that if all elements of the care bundle are implemented correctly, then the outcome surveillance will show a reduction in HCAs and if this is not achieved with a particular clinical team and/or consultant, then it will help to open up discussion with the individual clinical team and help understand the issues and barriers to implementation. Therefore, it is essential that process surveillance *must be linked* to outcome surveillance till all procedures and practices of the care bundle are standardised, implemented and fully embedded in the unit, and reduction in HCAs achieved.

Surveillance methods

Different methods of surveillance exist and their advantages and disadvantages are beyond the scope of this paper and readers should refer to papers 3 and 4 cited in the reference.

On a day-to-day basis, *laboratory-based ward liaison* surveillance is the most commonly used by the IPC team and this is also effective in low

resource countries. This is carried out by collecting information on *alert conditions* (which are medical syndromes such as chickenpox, diarrhoea etc.) on all new admissions with suspected infections. For this system to work effectively, it is essential that clinical

staff at ward level notify a member of the IPC team of all suspected cases of infection, either during the ward visit or by telephone to the IPC team. This system of identifying suspected infection is useful as microbiology laboratories take time to establish a diagnosis depending on the methods and facilities and in some instances the clinician may not have taken appropriate specimens or the specimen is taken after the start of antibiotic therapy. This is especially common in low resource countries as patients often go to the local pharmacist for medical consultation in the first instance. In addition, in the majority of low resource countries, microbiology laboratory facilities are either absent or may not have facilities to confirm or rule out the diagnosis of infectious diseases. Due to a lack of adequate medical manpower, doctors working in limited resource countries have a very heavy clinical workload and may not have time to take a proper history and/or knowledge to request appropriate laboratory investigations. Since availability of even basic laboratory facilities is not available, very heavy reliance is placed on clinical judgement based on the history, clinical examination and local epidemiology of the infectious diseases.

Box 1. Alert infectious conditions

- Surgical Site infections
- Diarrhoea and/or vomiting
- Diarrhoea with blood (dysentery or colitis)
- Typhoid and paratyphoid fevers
- Cholera
- Severe cellulitis e.g. necrotizing Fasciitis
- Tuberculosis
- Exanthemata
- Chickenpox or shingles
- Mumps, measles, rubella, parvovirus
- Whooping cough
- Poliomyelitis
- Diphtheria
- Scabies
- Meningitis
- Viral hepatitis
- Ophthalmia neonatorum
- Pyrexia of unknown origin
- Viral haemorrhagic fever

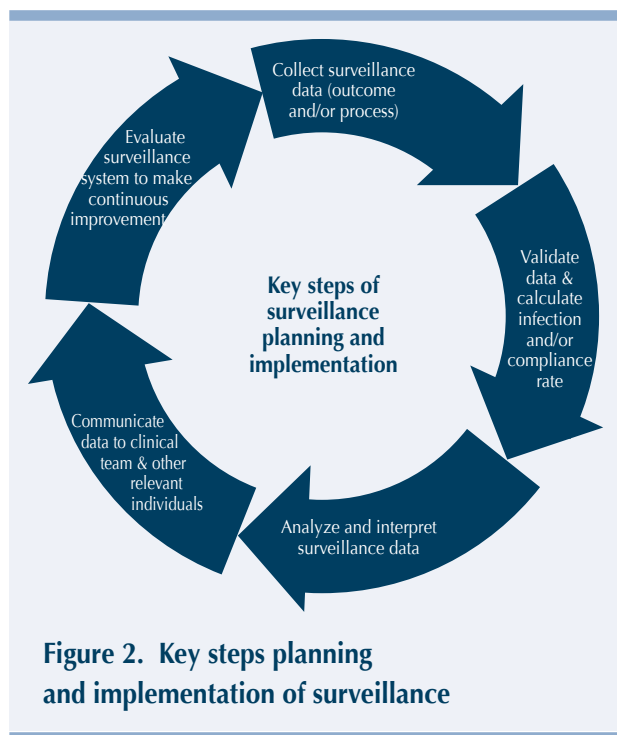
Box 2. Alert organisms

Bacteria

- Meticillin-resistant *Staph. aureus* (MRSA), other resistant *Staph. aureus* and Panton-Valentine Leukocidin (PVL)
- *Streptococcus pyogenes* (Group A), *Streptococcus agalactiae* (Group B)
- Penicillin-resistant *Strep. pneumoniae*
- *Legionella pneumophila* and other spp.
- Glycopeptide/vancomycin-resistant enterococci (GRE/VRE)
- Pathogenic *Neisseria* spp. e.g.
- *N. meningitidis*
- *N. gonorrhoeae*
- *Clostridium difficile*
- *Salmonella* or *Shigella* spp.
- *Escherichia coli* O157
- Multi-resistant Gram-negative bacilli e.g. ESBL, CRE (Carbapenem-resistant Enterobacteriaceae)
- Any unusual bacteria e.g. *Listeria*
- *Pseudomonas aeruginosa* in augmented care areas e.g. neonatal and intensive care units, burns units

Viruses

- Rotavirus
- Norovirus and other small round structured virus
- Respiratory syncytial virus
- Chickenpox/Varicella zoster
- Measles
- Mumps
- Rubella
- Parvovirus
- Influenza virus

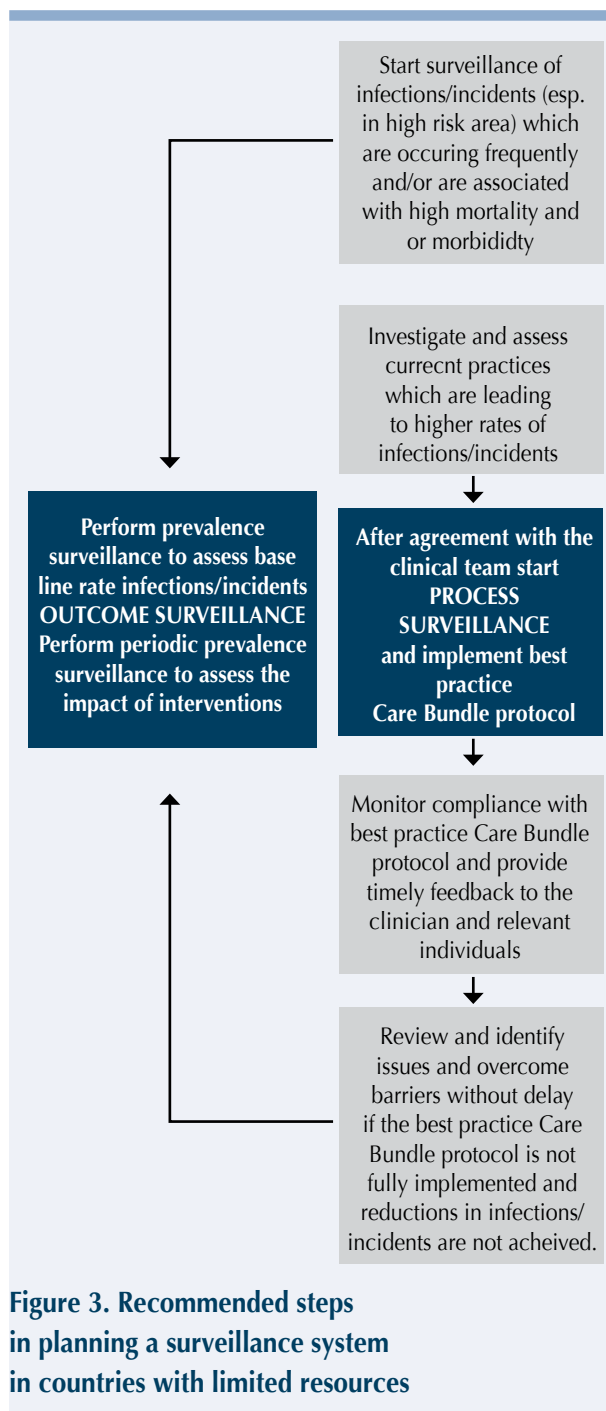


Surveillance of 'alert conditions' (see Box 1) should be used in conjunction with a search for positive reports from the microbiology laboratory for 'alert organisms' (see Box 2), which may result in a case review of patients or a search for other carriers/infected patients by ward visits. Alert conditions and alert microorganisms outlined in this paper provide a guide and each hospital/country should modify this list based on their epidemiology of multi-resistant microorganisms and local information on infectious and communicable diseases.

Combination of both 'alert conditions' and 'alert microorganisms' is useful and will help the IPC team to identify outbreaks and patients admitted with infectious conditions early so that appropriate IPC control measures are instituted immediately. However, this system has severe limitations if microbiology laboratory support is not available and the provision of diagnostic facilities is limited.

Surveillance planning

Figure 2 summarises the key steps of surveillance planning and implementation and Figure 3 recommends steps to be taken in starting and implementing surveillance system in low setting and/or countries. The requirements, limitations and challenges in setting up an effective HCAI surveillance programme in low to middle resource countries with



discussion on how to overcome some of these issues are summarised in Table II.

Key Stages of Surveillance

Collect surveillance data: For *outcome surveillance*, both numerator and denominator data must be collected as per definition which must be agreed with the clinical team and any issues with laboratory resources must be addressed in advance. Once the definition is agreed, it must be applied consistently and should not be changed once the surveillance has started. For *process surveillance*, the elements of care bundle

Table II. Summary of the requirements, challenges and practical points to overcome some of the issues in setting up an effective HCAI surveillance programme in low to middle resource countries.

| | Requirement to establish an effective surveillance programme | Issues and challenges in limited resource countries | Practical points to overcome some of the issues and challenges |
|---|---|--|---|
| Support of senior management and clinical team | No surveillance system will work <i>effectively</i> if there is a lack of support, commitment and back up from senior management (both medical and non-medical), as they have influence to establish IPC programme, provide support and resources required for surveillance. | For various reasons, support from senior managers (medical and non-medical) is often lacking. One of the main reasons is the lack of availability of local data of surveillance. | Senior management have lots of competing priorities so they need to be convinced that the surveillance is important. This can be done by explaining to them simply and clearly why you think that surveillance is important. This can be done by citing examples of <i>local</i> outbreaks and/or incidents related to HCAs. |
| Establishment of infection control infrastructure and associated support | Establishment of IPC infrastructure (establishment of IPC team and committee) is essential. This must be supported by provision of office space, secretarial and IT support. Availability of IT support (both hardware and surveillance and statistical software packages) is essential for data collection and analysis. Trained manpower is required to support a surveillance programme which includes collection, analysis and dissemination of data to relevant personnel. | Most health care facilities have no IPC infrastructure. IPC team and/or committee are either not fully established and/or not functioning effectively. Most of the countries have either no access and/or dedicated computer for the IPC team. Due to cost constraints, the availability of appropriate surveillance/statistical software packages is also not available. Trained manpower to support a surveillance programme is also lacking and even when the data are collected, they are not properly analysed and interpreted. Due to lack of IT infrastructure in the hospital and resources, the dissemination of data to relevant personnel is not always possible. | Senior management need to be convinced that investment made to establish and/or support IPC infrastructure and surveillance is not only important but also cost effective. In addition to saving cost, help them to understand that reduction in HCAs will release extra beds, improve quality of patient care and, provide safer environment for patients, staff and visitors. Make HCAI/incident reduction as a part of patient safety programme as each hospital has this item on agenda on their senior management meetings. This approach will help embed HCAI reduction as part of the organisational safety and quality improvement programme. |

| | Requirement to establish an effective surveillance programme | Issues and challenges in limited resource countries | Practical points to overcome some of the issues and challenges |
|--|--|--|--|
| Infection Prevention and Control Nurses and Doctors and/or epidemiologist | Need adequate number of <i>qualified</i> IPC nurses and doctors/epidemiologist. Dedicated time must be allocated for surveillance activity based on the individual institutional need and local priorities. | Most of the hospitals have either no IPC nurse or nurse with part time duties to IPC. Most of the IPC nurses have no qualifications and/or training in surveillance methods. In addition, most of the hospitals have either no/or part time IPC doctor and most of this job is given to medical microbiologists or clinicians without any clearly defined role or job description and most of them have no qualifications, experience or training in IPC. | Based on the available resources and local epidemiology, target only <i>preventable</i> HCAIs which are easy to reduce with minimum efforts i.e. 'pick low hanging fruits'! Depending on local resources and expertise, prioritise and start small in 'bite-size' chunks in one unit initially. Target high-risk areas/units (neonatal unit, intensive care, burns units etc.), or type of infections (infections caused by blood borne viral infections, bloodstream, surgical site infections etc.) and/or procedure directed (needle stick injuries, infections associated with indwelling devices etc.). |
| Laboratory Resource | Good laboratory support is needed (esp. microbiology) to support a surveillance programme. They must be adequately resourced to provide diagnostic microbiology based on the local epidemiology of multi-drug resistant organisms and communicable diseases. The lab should be accredited to ensure quality of diagnostic service. Daily reports on cultures can be accessed via computer by IPC and clinical staff for prompt action and evaluating possible outbreaks. | Most hospitals do not have even a basic laboratory to support a surveillance programme. If the laboratory support is available on site, it is not adequately resourced and only basic diagnostic tests are available. For various reasons, most labs do not perform internal Quality Control and do not participate in any external Quality Control scheme. They are also not accredited to international standards. The quality of diagnostic service is a big issue and misidentification of microorganisms and/or antibiotic susceptibility is not uncommon due to lack of resources and/or adequate training of lab technicians. One of the reasons is due to a lack of formal training and career pathways for lab technicians. Most labs lack computerisation, so access to daily reports and/or look back exercises can be very cumbersome. | Before agreeing definition with clinicians, make sure that your local laboratory has facilities and resources to support. Therefore, before starting any surveillance, it is crucial that you must discuss this with the Head of Laboratory service. Issues of additional resources must be addressed and communication of results must be clarified as most laboratories are not fully computerised. |

| | Requirement to establish an effective surveillance programme | Issues and challenges in limited resource countries | Practical points to overcome some of the issues and challenges |
|-------------------------------------|--|---|--|
| Medical and nursing manpower | Provision of adequate manpower both medical (doctors and nurses) and non-medical is crucial to participate in surveillance activity. For surveillance to work effectively, clinical teams must have time to communicate and help IPC in the collection of data by filling in necessary forms and help assess the definition of HCAs as per agreed guidelines as a part of data validation process for surveillance. This is essential so that clinical teams have ownership and feel part of surveillance process. | Adequate manpower especially medical (doctors and nurses) is lacking and as a result their first priority is to provide clinical service rather than to complete paper work and assess patients with HCAI as per definition. In addition, due to clinical priorities, finding time to attend educational sessions on surveillance and attend regular meetings is difficult to achieve. | Choose a unit where you have full support and agreement from the clinical team. For the surveillance programme to be successful, foster a sense of ownership, as experience has shown that clinical teams often perceive the process of surveillance as being something that is done 'to' them and not 'by' them. Agree definitions with the clinical team, taking into consideration the availability of personnel in the unit and their clinical workload. Finally, provide education, training and support for all those who are involved in the surveillance process to ensure consistency. |
| Availability of the Products | Availability of sterile goods and other items/products are essential for implementing good IPC practices to reduce HCAs. | Availability of basic products (antiseptic products, alcoholic hand rub, sterile gloves, dressing and other items, e.g. IV and urinary catheters are not always readily available. As a result reuse of items e.g. 'sterile' gloves, IV and urinary catheters without adequate sterilisation, is not uncommon. | Before starting surveillance, discuss and obtain agreement from senior management so that any issues relating to the availability of products are addressed in advance. |
| Follow up in the community | Computerisation of laboratory and availability of good medical record department is essential for prompt retrieval of information for surveillance. It is also essential that patients must have a proper postal address and/or telephone number to contact if follow up is needed. | Most of the laboratories in low to middle income countries are not fully computerised and medical record department is not well established, making retrieval of information very difficult and cumbersome. The great majority of patients receiving treatment in health care settings in these countries have no proper address and/or access to telephone so follow up of these patients is not always possible. | This is a challenging task even in high resource countries where surveillance programmes have been well established for decades. Additional issues in low to middle resource countries include high clinical work load with limited medical and nursing manpower, lack of availability of computerised medical records, and other resources in healthcare facilities. This is further compounded by the fact that most patients don't turn up at the follow-up clinic, and contact is not always possible due to lack of proper home address and wider availability telephone. |

must be agreed in advance with the clinical team and process must be agreed on the collection and dissemination of the data. Monitoring of care bundle also needs both numerator and denominator data to calculate the percentage of compliance with all the elements of care bundle.

Validate and calculate data: Outcome surveillance data must be validated, as Ronald Thisted has said that '*Raw data, like potatoes, usually require cleaning before use*'.²⁰ Active participation of the clinical team is crucial as it will not only give them a sense of ownership but because they are part of the validation process, the data (both the outcome and the process) will be more meaningful and therefore having a better chance for success to implement change in practice.

Data on process surveillance must be fed back without delay because according to Institute of Healthcare Improvement, 'rough and ready' data which are 'good enough' figures are preferable to 'cleansed' data which are provided late.¹⁴ In addition, it is important to emphasise that process data is *measurement for improvement* and not judgement.

Analyse and interpret data: Irrespective of the methods used, it is essential that data generated from the surveillance must be analysed and appropriately risk-adjusted (esp. for surgical site infections). This is essential especially if this information is released beyond the institution for inter- and intra-hospital comparisons.²¹

The data must be interpreted correctly and appropriate statistical methods should be applied to prove that applying evidence-based practices during pre and post intervention periods reduces HCAIs. For outcome surveillance, infection rate can be calculated by collecting *both* numerator and denominator data as analysis of numerator data alone is meaningless. Monitoring of care bundle is presented as the percentage of compliance with all the elements of care bundle.

Communicate data to relevant individuals: Collecting and recording data is a futile exercise if no further action is taken. Therefore the most vital component of both types of surveillance is to ensure that the

information obtained is conveyed in a *timely manner* to those who may influence practice, implement change, and provide financial resources and managerial back-up which are necessary to improve the outcomes. This means that the information should be provided not only to the clinical team but also to the relevant senior health service managers.

Outcome data of HCAIs can be displayed prominently either as infection per 1,000 device days or as infection per 1,000 bed days. Process surveillance data can be displayed using 'run chart' (graph that displays observed data in a time sequence) and 'Statistical Process Control' chart (which monitor infection rate over time and allows us to evaluate trends to ensure that the process/parameter is being maintained within acceptable statistical bounds). Visual representations of surveillance data are essential for engaging clinical teams and this should be displayed *prominently* in the unit.

Evaluate the surveillance system. Regularly evaluate surveillance system to ensure that it is meeting its objectives (i.e. reduction of HCAIs and/or incidents). Any issues, barriers and challenges must be addressed immediately as part of patients', visitors and health care workers safety issue. The surveillance system also requires constant evaluation on a regular basis and necessary modification should be made as part of continuous improvement programme (Figure 3) to ensure that system is *alive* and *effective*.

Root cause analysis

RCA is based on the concept that problems are best solved by attempting to address and take corrective action to eliminate the *root causes* rather than merely addressing the immediately obvious issues which have resulted in HCAIs. In recent years, RCA has been successfully applied in the UK to reduce MRSA bacteraemia and *C. difficile* infections (<http://www.clean-safe-care.nhs.uk/>). Experience has shown that RCA can be used to compliment surveillance with the aim to identify the *root causes* of preventable HCAIs. Information gathered by the RCA over a long period may make it useful as a *proactive method* and if effectively carried out can be used to *forecast* or predict probable events even *before* they occur. It is recognised that complete prevention of recurrence by

one corrective action is not always possible and for this tool to be effective, corrective actions must be taken at an appropriate time and all the recommendations to prevent its recurrence must be followed and implemented both by clinical and non-clinical staff to close the loop. Thus, RCA is often considered to be an iterative process, and is frequently viewed as a tool of *continuous improvement* to reduce HCAIs.

Effective, implementation of RCA helps clinical teams to take time out from their busy schedule to look deep enough, analyse and reflect on the preventable HCAIs and helps them to gain understanding why unexplained and unfavourable things occurred to their patients.

If resources allow, Root Cause Analysis should be added to the surveillance process to achieve substantial and sustained reduction of HCAIs on a long term basis.

Conclusions

In summary, a substantial reduction of HCAIs can only be achieved if the outcome surveillance is combined with the process surveillance. This approach is essential to assess the problem by *outcome surveillance* and monitor the effectiveness of interventions by *process surveillance*. If the resources allow, further reduction can be achieved and sustained on a long term basis if the Root Cause Analysis of all preventable HCAIs can be added to the surveillance process.

In the limited resource countries, 'outcome surveillance' in the form of (point) prevalence surveillance is used initially in a targeted area to assess the extent of the problem and then resources should be diverted to educate the clinical team to implement standardised evidence-based practice and compliance of processes should be monitored to ensure that agreed best IPC practices are implemented and embedded in the unit to reduce HCAIs. It can be argued that if we *control the process* then we can *control the outcome*. Periodic prevalence surveillance should be carried out to monitor outcome (e.g. reduction in HCAIs or incidents) and data should be fed back to the clinical team and senior manager to motivate staff and this will help increase and sustain improvement in the unit.

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