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The case for reducing hospital-acquired infections in India

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LIST OF ABBREVIATIONS

CABG: Coronary artery bypass grafting

CAUTI: Catheter-associated urinary tract infection

CDC: Centers for Disease Control and Prevention

CLABSI: Central line-associated bloodstream infection

CRBSI: Catheter-related bloodstream infection

ECDC: European Centre for Disease Prevention and Control

HAI: Hospital-acquired infection

ICU: Intensive care unit

INICC: International Nosocomial Infection Control Consortium

MRSA: Methicillin-resistant Staphylococcus aureus

SSI: Surgical site infection

VAP: Ventilator-associated pneumonia

VRE: Vancomycin-resistant Enterococci

WHO: World Health Organisation

1 Introduction to hospital-acquired infections

> *"Infections contracted during hospital stays lead to unnecessary suffering and death for millions of patients every year".*

1.1 What is an HAI?

This paper discusses the global scale and scope of the HAI problem, the consequences of HAIs, some solutions to reduce HAIs, and future perspectives on infection control. The paper highlights the urgent need to assess and reduce infections in Indian healthcare facilities, and provides guidance on how to achieve this through policy changes.

Healthcare facilities worldwide pose a unique infection risk to patients. Infections contracted during hospital stays lead to unnecessary suffering and death for millions of patients every year. Such infections are called **hospital-acquired infections (HAIs)**, and can be defined simply as **an infection contracted in a hospital environment.**[1] Many HAIs are preventable and unnecessary, and are costly to deal with, both financially and in terms of physical and staff resources. They represent an unrecognised global drain on resources.

Correctly classifying infections is important to accurately assess HAI levels. Many healthcare facilities focus on infections present at the time of hospital admission, and do not classify as HAIs any infections that present within the first 48 hours after hospital admission. However, many HAIs are not recognised or counted as they only present after a patient has been discharged from hospital. Infections acquired in hospital may be asymptomatic for some time, and may only become obvious once a patient is back home. Obtaining the most accurate picture of HAI levels means acknowledging if a patient presenting with an infection has been discharged from hospital within the previous week.[2]

Hospitals are intended as centres of healing and care, so health threats that occur because of hospitalisation might seem counterintuitive. There are, however, numerous reasons why these complex and busy environments are a focal point for infectious disease.

Many visitors and healthcare staff enter and pass through hospitals every day, which can introduce new infections to the hospital environment, and help to spread existing infections throughout busy facilities. In particular, frequently touched surfaces, such as door handles and medical equipment, can transmit infectious agents.

Other factors contributing to infectious disease in hospitals include patients with contagious illnesses and patient exposure to infectious bodily fluids and other medical waste. Routine medical procedures, such as surgery, intubation and catheter placement, can allow infectious agents to enter the body.

Healthcare facilities are also sites for antibiotic-resistant organisms, which cause some of the most dangerous and difficult-to-treat infections. Patients undergoing antibiotic therapy increase the development of antibiotic-resistant microbes in the hospital environment, thereby increasing

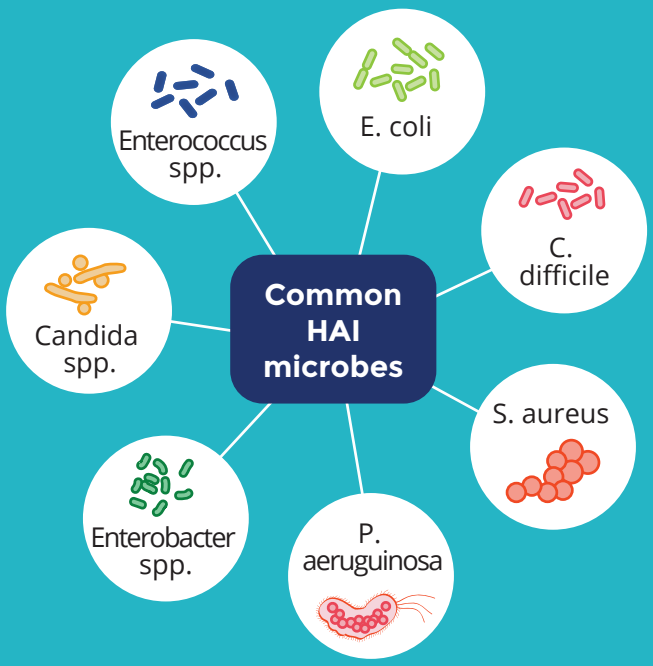
What is a hospital-acquired infection?

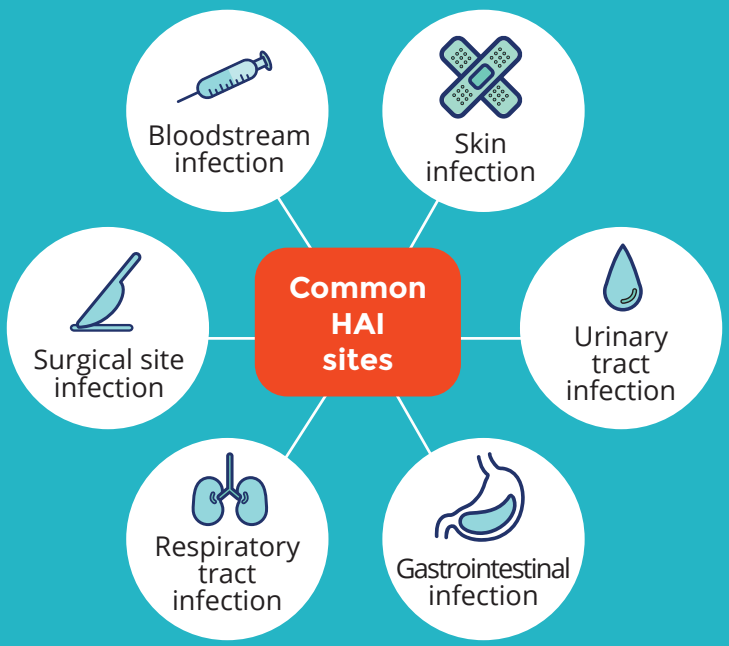
A hospital-acquired infection (HAI):

Is an infection that is contracted in a hospital environment

Is not present at the time of hospital admission

Typically manifests beyond 48 hr after admission





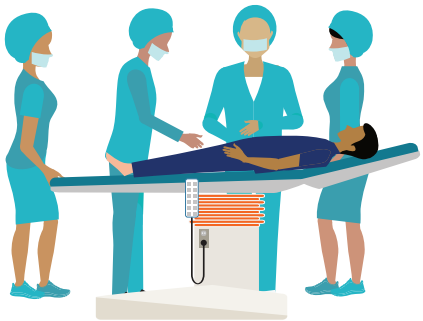
Common sources of infection:

Frequently touched surfaces

Doctors & nurses not washing hands

Dirty bed linen, gowns

Unsterilized diagnostic tools



Other patients

Unsterilized surgical tools

Indwelling catheters

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the overall risk of dangerous infections.

Many hospitalised patients, including elderly and immune-compromised patients, are particularly susceptible to infection. Intensive care units (ICUs), which contain some of the most vulnerable patients, often have a heavy burden of infection. Given these issues, it is unsurprising that healthcare facilities around the world are associated with significant levels of patient infection.

1.2 Common infectious agents and types of HAI

Hospitals are reservoirs for many infectious agents that can cause HAIs. These include viruses (such as influenza), fungi (such as Aspergillus), and bacteria (such as Clostridium difficile). Some of the most dangerous infections are those caused by antibiotic-resistant bacteria, also known as "superbugs", such as methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant Enterococci (VRE), for which

HAIs can arise in a huge array of tissues, and their severity depends on the site of infection, the infecting microbe and the health status of the patient. Medical devices, such as catheters and ventilators, can provide an access point for microbes to enter the body. Some common and important HAIs are listed below.

Central line-associated bloodstream infections (CLABSIs)
A central line is a tube inserted into a vein for drug treatments. If central lines are unclean, inserted incorrectly, or left in place for too long they can allow bacteria into the bloodstream, causing serious infection.

CLABSIs are sometimes included in a wider group of infections called catheter-related bloodstream infections (CRBSIs), which include infections caused by a variety of catheters.

Ventilator-associated pneumonia (VAP)
If a patient cannot breathe by themselves, medical staff may place a tube down the throat into the airway. The tube is attached to a mechanical ventilator that helps the patient to breathe. This breathing tube can provide a route for bacteria to enter and infect the respiratory system, resulting in pneumonia.

Surgical site infections (SSIs)
Bacteria can enter the body during or after surgery, causing an SSI. These infections sometimes involve only the skin and superficial tissue, but can also affect deeper tissues and internal organs.

Catheter-associated urinary tract infections (CAUTIs)
Urinary catheters can provide a route for microbes to infect the urinary tract, bladder and kidneys. Typically, problems arise if catheters are unclean, inserted incorrectly, or are left in place for too long.

C. difficile gastroenteritis
C. difficile can infect the gastrointestinal system, causing severe diarrhoea.[4] Patients can contract such infections from healthcare workers who do not adhere to appropriate hand-washing protocols, or do not wear appropriate personal protective equipment, such as gloves.

HAIs are a global healthcare phenomenon that results in significant patient morbidity and mortality. The emergence of multi-drug-resistant bacteria can seriously complicate even routine surgeries.

There is an urgent need to tackle HAIs globally. Emerging countries, such as India, are particularly struggling under a significant HAI burden.

2

The global scale and scope of the HAI problem

The global scale of the HAI problem is staggering. Global HAI levels are difficult to estimate because many countries do not have adequate surveillance systems with which to record reliable HAI data. Nonetheless, the World Health Organisation (WHO) has reported that HAIs are one of the most frequent adverse events in healthcare facilities. Hundreds of millions of patients are likely to suffer HAIs annually, with a higher burden in lower-middle income countries compared with higher income countries.[1] This section discusses the global HAI problem and the disparity between high-income and emerging countries.

2.1 HAIs in high-income countries

Compared with emerging countries, high-income countries typically spend a greater proportion of gross domestic product on healthcare, and deploy greater levels of healthcare resources, such as increased staff levels and more advanced medical equipment and drug therapies. These measures, coupled with rigorous HAI monitoring and specific infection-control measures, have helped such countries to reduce their HAI burden. However, HAIs are far from eradicated, demonstrating that further work is required globally.

2.1.1 HAIs in Europe and the U.S.

The European Centre for Disease Prevention and Control (ECDC) has estimated that over 4 million patients in the European Union suffer at least one HAI annually, contributing to 110,000 deaths (2.75%).[5]

HAI levels are particularly high in ICUs. A large ECDC study in 2016, involving ICU patients in 15 European countries, reported that 8.4% of patients staying in the ICU for more than two days contracted at least one of three HAIs: pneumonia, bloodstream infections or urinary tract infections. Medical devices were a huge factor in those patients who contracted pneumonia, with 99% of cases involving a breathing tube. For those who contracted urinary tract infections, 97% of cases involved a urinary catheter. Antibiotic resistance was also a significant issue, with 30% of S. aureus samples taken from infected patients confirmed as showing MRSA.[6]

The average percentage of European patients (from all types of hospital wards) who contract an HAI has been reported as 5.9%, but some European countries have significantly higher levels, such as Portugal at 10.8%. One study has reported that an average of 19.5% of European ICU patients had at least one HAI.[5]

In the U.S., one CDC report estimates that 4.5% of patients suffer an HAI annually, corresponding to a total of 1.7 million patients.[1] An HAI prevalence survey in 10 U.S. states estimated that 648,000 patients suffered an HAI annually in U.S. acute care hospitals alone. The results indicate that on any given day, one out of every 25 patients in U.S. acute care hospitals has at least one HAI. C. difficile was the most commonly reported infecting microbe, involved in 12.1% of infections, while medical-device-related infections accounted for approximately 25% of infections, and pneumonia and SSIs were the most common infection types.[7]

As in Europe, in the U.S., medical devices are a significant source of HAIs. One study reported that 87% of bloodstream infections occurred in patients fitted with a central line, and 83% of cases of hospital-acquired pneumonia were associated with mechanical ventilation.[1]

2.2 HAIs in emerging countries

Although the level of HAIs in high-income countries is not insubstantial, emerging countries typically have much higher HAI levels. It is difficult to accurately quantify the levels of HAIs in many emerging countries, as they lack nationwide HAI surveillance programmes. However, much of the research reported to date indicates that HAI levels are significantly higher in emerging countries.

A large meta-analysis performed by the WHO found that the overall prevalence of HAIs in a group of low- and middle-income countries (including India) was as high as 15.5% in high-quality studies. This is much higher than typical estimates for the U.S. and Europe (4.5% and 5.9%, respectively). The study found that the density of ICU HAIs in low- and middle-income countries was at least three times that reported in the U.S., and SSI rates of 5.6 per 100 surgical procedures were almost twice those reported for the U.S. and Europe. Medical-device-related HAIs are a significant issue in high-income countries, but levels of device-associated infection were found to be 2–8 times higher in emerging countries. In some countries these levels were up to 19 times higher for certain infections.

The meta-analysis included eight studies where MRSA was present in S. aureus samples taken from HAI patients in emerging countries. An average of 54% of such samples contained MRSA. This indicates a significant antibiotic-resistance issue. However, there was a lack of studies from emerging countries that investigated the presence of antibiotic-resistant bacteria in HAIs, indicating that such analysis is not routinely performed or reported in many

"Numerous small-scale and regional studies have revealed a variable but significant burden of infection in Indian healthcare facilities."

developing countries.[8]

2.2.1 HAIs in India

As an emerging country, India is also struggling with HAIs. Numerous factors contribute to HAIs in India: These include over-burdened medical infrastructure for the size of the population; low staff awareness of HAIs; inconsistent adherence to simple infection-control procedures, such as hand-washing and personal protective equipment; wide availability and indiscriminate use of antibiotics; inconsistent measurement of the issue; and a lack of a coordinated approach across the healthcare sector to combat HAIs.

There is no nationwide HAI surveillance programme in India, so nationwide data are not available. However, numerous small-scale and regional studies have revealed a variable but significant burden of infection in Indian healthcare facilities.

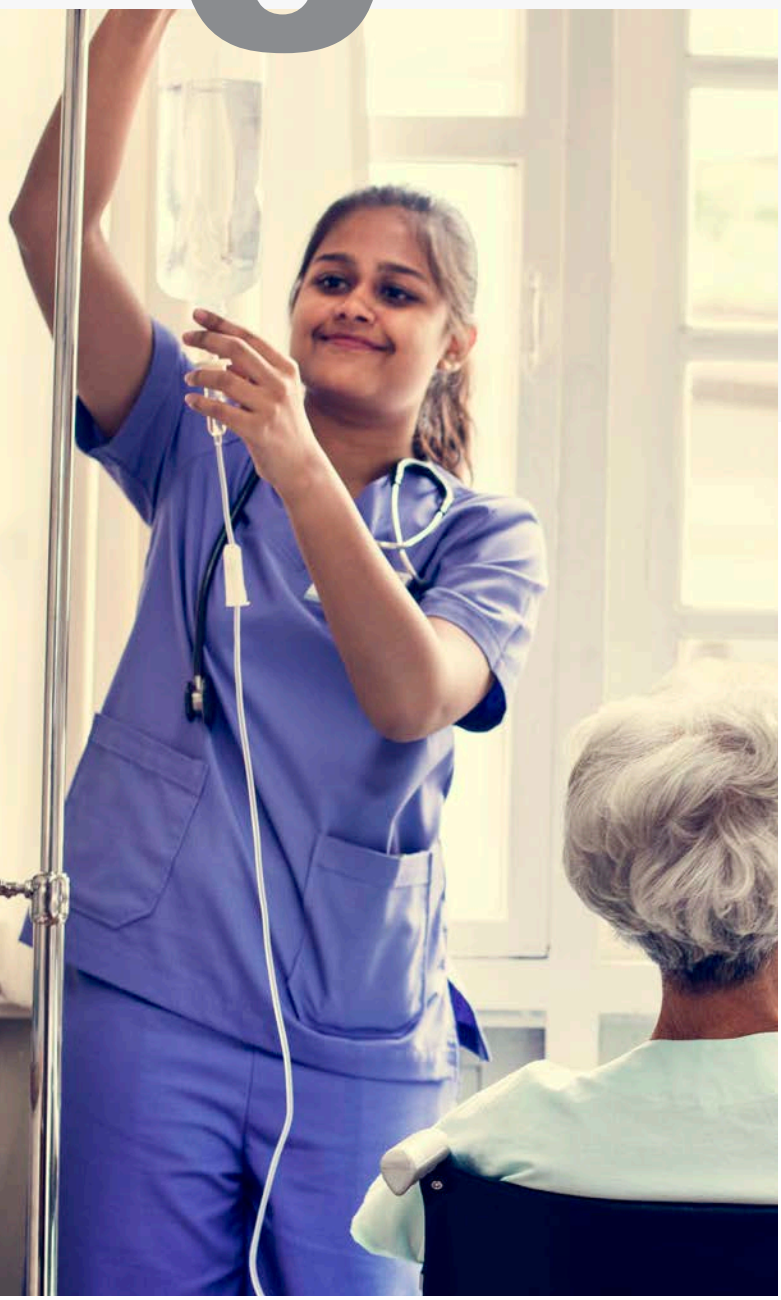
A small study from 2017 examined levels of VAP, CAUTI and CRBSIs in an Indian ICU. The study showed that 50% of patients admitted to the ICU developed one or more HAIs, and multi-drug resistance was found in 74% of the bacterial samples from infected patients.[9]

A review of HAIs in Indian hospitals reported an HAI rate ranging from as low as 4.4% to as high as 83.09%. It also reported an alarmingly high burden of MRSA in ICUs in seven Indian cities, where 87.5% of all S. aureus infections were caused by MRSA.[10] The International Nosocomial Infection Control Consortium (INICC) reported that Indian ICUs had an average CLABSI rate of 7.7 infections for every 1,000 days a patient is fitted with a catheter (catheter days). This is significantly higher than the equivalent rate in U.S. ICUs of 1.5 CLABSIs per 1,000 catheter days.[11]

The INICC also conducted a large-scale long-term ICU HAI surveillance project in 40 Indian hospitals in 20 cities from 2004 to 2013. The study was the largest HAI surveillance effort in India to date, and used standardised surveillance methods advocated by the U.S. National Healthcare Safety Network to assess levels of medical device-associated HAIs. The study found significant levels of VAP (9.4 cases per 1,000 ventilator days), CLABSI (5.1 cases per 1,000 central line days) and CAUTIs (2.1 cases per 1,000 urinary catheter days), which were higher than equivalent values reported by the U.S. National Healthcare Safety Network. In addition, the study found higher antimicrobial resistance rates in the Indian sites.[12]

The consequences of HAIs

3



HAIs have a variety of negative consequences, both personal and societal. They are a significant source of morbidity and mortality worldwide, and result in substantial increases in healthcare costs, lost earnings and decreased productivity. This section highlights some of the major issues caused by HAIs to illustrate the urgent need to tackle this problem.

3.1 HAIs and direct healthcare costs

One of the most significant issues associated with HAIs is spiralling healthcare costs. These cost increases result from the need for additional drug treatments and laboratory diagnostic testing, as well as containment and decontamination efforts, including patient isolation and disinfection of equipment and rooms.

The effect of HAIs on healthcare costs can be substantial. For example, the WHO reported that direct costs associated with HAIs in Europe alone are approximately €7 billion annually, based on 16 million days of additional hospital stays for affected patients.[1]

In the U.S., a meta-analysis of HAI-associated healthcare costs found that per patient, CLABSI costs an average of $45,814, VAP costs $40,144 and SSI costs $20,785. When combined with C. difficile infections and CAUTIs, this analysis estimated that these five major infections cost $9.8 billion annually in the U.S.[13]

Other reports have estimated that HAIs in U.S. hospitals may cost between $28 billion and $45 billion annually. Although this range is large, it reflects the variability in the assumptions made in such analyses, the studied patient populations and the methods used to generate such estimates. Regardless, it is clear that HAIs are an extremely expensive phenomenon.[14]

The Consequences of Hospital-Acquired Infections

- Increased healthcare costs
- Reduced staff and physical resources
- Increased antibiotic resistance

- Prolonged hospital stays
- Increased antibiotic treatments
- Increased need for containment and disinfection

- Impaired ability to prevent further infections

HAI

- Chronic illness
- Disability
- Death
- Psychological distress

- Reduced national productivity
- Reduced tax revenue
- Reduced healthcare spending

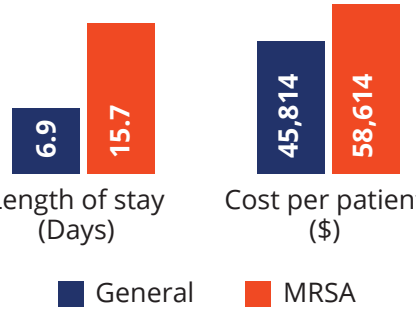
- Reduced ability to work
- Lost income
- Need for a carer

16 million
excess hospital days annually in Europe

€7 billion
annual direct healthcare costs in Europe

Antibiotic resistance increases costs and length of stay

Central line-associated bloodstream infections in U.S. acute-care hospitals



100,000
deaths annually in the U.S.

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Sources: World Health Organisation: Healthcare–associated Infections Fact Sheet

Economic burden of healthcare associated infections: An American perspective. Expert Review of Pharmaeconomics & Outcomes Research

Health Care–Associated Infections A Meta-analysis of Costs and Financial Impact on the US Health Care System. JAMA Internal Medicine

3.2 The consequences of antibiotic-resistant infections

Infections caused by antibiotic-resistant bacteria are difficult and costly to treat. A meta-analysis found that average costs associated with CLABSI caused by MRSA were $58,614 per patient, while CLABSI and SSI caused by MRSA resulted in average increases in hospital stays of 15.7 and 23 days, respectively.[13]

Infections caused by VRE can also have significant consequences. Vancomycin is considered one of the antibiotics of last resort, so the emergence of vancomycin-resistant bacteria is particularly worrying. Some U.S. studies have found that, depending on the health of the patient, VRE infection can increase hospital stays by up to 27 days, and can increase hospital costs between $31,915 and $52,449 per patient.[15]

3.3 HAIs and patient morbidity and mortality

Aside from direct increases in healthcare costs, HAIs can lead to long-term illness and disability, and associated costs. This can create a host of related problems, including the inability to work, the need for long-term care, lost earnings and productivity, psychological distress and reduced quality of life. In particular, loss of productivity and earnings can affect both HAI patients and their carers. These issues can persist long after a patient is discharged from hospital, creating a variety of long-term personal and societal problems.

Chronic, life-altering illness is intrinsically linked to HAIs. A study in Taiwan investigated the outcomes of 3,070 patients with HAIs caused by Staphylococcus aureus. The study showed that infected patients were at increased risk of chronic ventilator dependence and dialysis-dependent end-stage renal disease, both of which can have significant long-term impact on quality of life, ability to work and productivity.[16]

HAIs are also associated with significant patient mortality. The U.S. CDC estimates that 100,000 people with HAIs in the U.S. die annually, and HAIs were reported as the fifth leading cause of death in U.S. acute care hospitals.[14] A survey of HAIs in acute care hospitals in the U.S. found that 11.5% of 436 patients suffering HAIs died during the hospitalisation period in which they were surveyed.[7]

HAI-associated mortality is a global issue; however, levels of HAI-associated mortality in emerging countries are particularly concerning. It is difficult to directly compare HAI-associated mortality levels across different countries, and HAI mortality figures from emerging countries are incomplete, but some research has provided an insight into the huge burden of HAI-linked death in low-resource healthcare environments.

One study investigated mortality levels in patients with HAIs arising from invasive medical devices in ICUs in 46 hospitals that are members of the INICC, in eight emerging countries (including India). The crude mortality rate ranged from 35.2% for central venous CRBSIs to as high as 44.9% for VAP. The study concluded that device-associated infections in such low-resource settings are a higher risk to patient safety than equivalent infections

in U.S. ICUs, and that HAI surveillance and control are urgently needed to rectify this.[17]

3.4 The consequences of HAIs in India

HAIs in India also result in significant increases in healthcare costs, morbidity and mortality. This is particularly concerning because the available data indicate that Indian healthcare facilities have high levels of HAIs, and are frequently under-resourced and ill-equipped to prevent and deal with HAIs. Given that a significant proportion of HAIs are preventable, money spent dealing with their consequences is largely wasted, and could be better spent on improving hospital conditions and patient care. HAIs are a substantial hurdle to effective healthcare in India, and represent a stumbling block for the Indian healthcare system.

There is a lack of national data concerning the consequences of HAIs in India, but several small-scale and regional studies have highlighted the impact of these infections. A study of 1,125 surgeries found that patients who suffered an SSI incurred healthcare costs of Rs 29,000 compared with only Rs16,000 for uninfected patients. Uninfected patients had average ward and ICU stays of 5.5 and 1.6 days, respectively, whereas for those who suffered an SSI this was increased to 17.2 and 8.7 days, respectively. The incidence of mortality was increased from 3.8% in the uninfected to 12.8% in those with an SSI.[18]

A larger study of HAIs in 40 Indian hospitals found that average ICU stays were increased by 9.5 days for CLABSI, 9.1 days for VAP and 10 days for CAUTI. The study also found that crude mortality was increased by 16.3% for CLABSI, 22.7% for VAP and 6.6% for CAUTI. In neonatal ICUs, infection-related prolonged ICU stays were more severe, with increases of 14.7 days for CLABSI and 38.7 days for VAP.[12]

The overuse and misuse of antibiotics in India contributes to antibiotic resistance, which makes treating HAIs particularly difficult and expensive, and also contributes to HAI-related morbidity and mortality. Multi-drug-resistant bacteria may require high-end specialised antibiotics, such as carbapenems or newer tetracyclines, thus contributing to HAI expense.[10]

4 Success stories in reducing HAIs

HAIs are a formidable global threat to patient health, but coordinated action by policymakers and healthcare officials can successfully tackle this problem. This section covers some success stories from around the world, identifies effective strategies, and shows that controlling HAIs is an achievable and worthwhile goal.

4.1 Infection control in the U.S.

In the U.S., the CDC has been leading coordinated action against HAIs. In 2016, the CDC published a progress report on HAI prevention covering the previous eight to ten years. Their success in reducing the incidence of certain HAIs is striking. The CDC attributes this success to a significant increase in collaboration between healthcare providers, support from a variety of agencies, and specific programmes to increase healthcare staff awareness and compliance with best practice.
One of the major factors underlying the successful control of HAIs in the U.S. is a rigorous surveillance and reporting system. Collecting and sharing national infection data provides healthcare facilities and health agencies with the correct knowledge to design and implement effective infection control strategies. Ongoing monitoring and progress evaluations then reveal if such interventions are working.

"One of the major factors underlying the successful control of HAIs in the U.S. is a rigorous surveillance and reporting system".

Between 2008 and 2016 the CDC progress report indicates that there was an approximate 50% drop in CLABSIs nationally. Increased awareness among U.S. healthcare workers had enabled them to more carefully assess the need for a central line in each patient, resulting in reduced and safer central line placement and fewer infections.[19]

The U.S. has also developed a specific action plan to tackle some of the most serious HAIs – those caused by antibiotic-resistant bacteria. The National Action Plan for Combating Antibiotic-resistant Bacteria was created in 2015 in response to an executive order from the Obama administration to tackle the growing threat of treatment-resistant HAIs.[20,21] This plan aims to comply with World Health Assembly resolution 67.25 (Antimicrobial Resistance), which encourages efforts to fight antibiotic resistance at local, regional and national levels.[22] As bacteria do not respect international borders, international collaboration is essential to tackle the problem.

Running from 2015 to 2020, the plan includes specific goals to slow and reduce the emergence of resistant bacteria, increase and strengthen surveillance efforts, enhance and expedite the development of new diagnostic tests, vaccines and antibiotics, and increase international collaboration.[20]

One of the key factors in dealing with outbreaks of dangerous antibiotic-resistant bacteria is appropriate containment: the CDC has developed a containment strategy to deal with serious outbreaks, including those

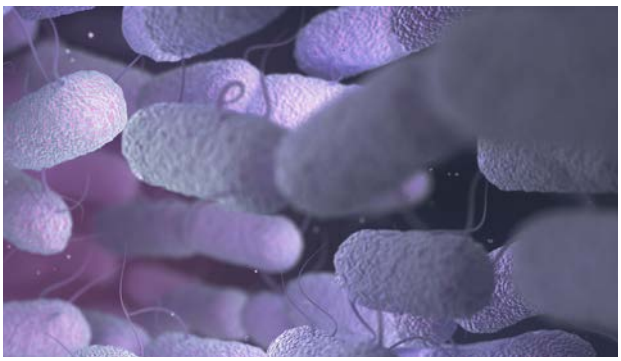
of "nightmare" bacteria, such as carbapenem-resistant Enterobacteriaceae. Their strategy relies on the rapid identification and containment of such urgent threats, and involves a network of specialised laboratories in all 50 states. Local healthcare facilities can coordinate with the laboratory network if they identify a dangerous or previously unknown antibiotic-resistant bacterium.

In 2017 alone, this laboratory network uncovered 221 instances of bacteria with unusual antibiotic resistance. The programme also identified difficult-to-treat bacteria that can spread easily throughout healthcare facilities in up to 10% of screening samples taken from symptomless patients. The response to such threats involves characterising the organism, identifying and preventing transmission, and potentially isolating affected patients.[23]

Implementing monitoring and infection-control strategies, and assessing progress, can be hugely effective in terms of reducing HAI levels, resulting in significant healthcare savings. One study in the U.S. showed that ongoing investment in infection-control programmes substantially reduced patient mortality and provided enhanced quality of life, with significant reductions in overall healthcare costs.[24]

4.2 U.S. case studies

Below are two specific cases within the U.S., one at state level and the other within a single hospital, where successful infection control was achieved.



U.S. case studies

Case 1

Barnes-Jewish Hospital in St. Louis, Missouri[25]

Problem: The hospital staff began improving their approach to HAIs when they noticed an increase in SSIs following coronary artery bypass grafting (CABG). They found that there had been a breakdown in best practice at the hospital.

Methods: A culture change at the hospital included a staff re-education programme and increased staff accountability. The hospital placed charts in corridors tracking monthly HAI progress to increase staff motivation and awareness. For every recorded HAI, staff members tried to determine if there had been a breakdown in best practice. This was a learning experience, and reduced repeated mistakes.

Results: Within five years the rate of CABG SSIs at the hospital was down to zero, and over the next few years it remained very low, including one period where it remained at zero for 15 months. The hospital's long-term strategy includes setting progressively more ambitious goals for lower HAI rates, investigating and learning from each infection, maintaining staff accountability, and celebrating successes and milestones.

Case 2

Maryland Hospital pay-for-performance hospital-acquired conditions programme[26]

Methods: The state of Maryland introduced a programme providing strong financial incentives and penalties to encourage hospitals to reduce their HAI numbers. Poorly performing hospitals were penalised but highly performing hospitals received a financial reward.

Results: Over just two years, HAIs were reduced by 15.26%. This translated to an estimated saving of $110.9 million in Maryland over the same period, and it was estimated that a similar nationwide scheme could save as much as $1.3 billion over two years.

4.3 The Dutch approach

The Dutch healthcare system boasts some of the lowest levels of MRSA colonisation and infection globally. In many countries, 20–50% of S. aureus samples isolated from patients in medical centres are routinely identified as MRSA. In The Netherlands, this figure is as low as 1%. This has been achieved using a variety of methods.

The Netherlands enforces a restrictive antibiotic prescription policy, thus limiting the development of antibiotic-resistant bacteria by reducing inappropriate antibiotic use. In addition, the Dutch healthcare system employs a "Search and Destroy" policy to specifically target MRSA in healthcare facilities.

The "Search and Destroy" system is based on actively testing people who are at risk of carrying MRSA. This includes family members of, and patients in close proximity to, someone who has been confirmed as colonised or infected. Healthcare workers use a variety of containment techniques to prevent transmission between identified or suspected carriers and other patients. This includes isolation and, in some cases, decolonisation treatments.

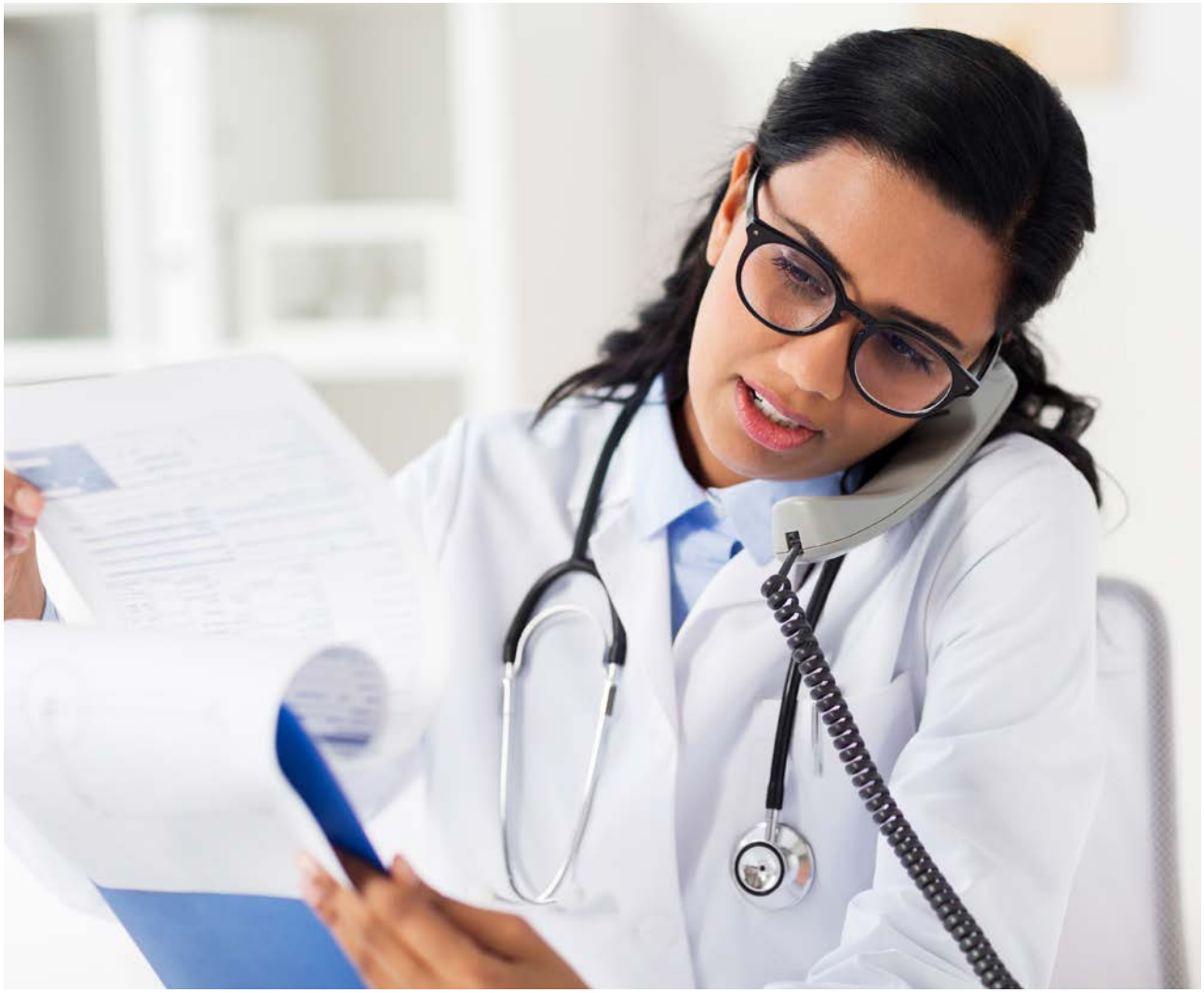
The policy includes strict procedures for dealing with MRSA-positive patients, including regular disinfection of isolation rooms, and hand-washing protocols and personal protective equipment for staff. After patients are discharged, staff conduct follow-up tests to check that decolonisation has been successful.[27,28] Although the technique is labour-intensive, and frequently requires pre-emptive action, it can be highly effective, with some studies reporting a reduction in MRSA infections of up to 70% in hospitals following "Search and Destroy" programmes.[29]

4.4 HAI solutions in India

There have also been some encouraging signs of progress in efforts to reduce HAI levels in India. Given that India is struggling with a relatively high HAI burden, there is a lot to gain by tackling the problem. To date, most of the information on HAI levels and efforts to control infections in India comes from reports by individual hospitals; therefore, it is difficult to assess the overall problem, and challenging to design effective national infection-control strategies.

Many Indian healthcare facilities take an isolationist view, and are unwilling to share negative data. This means that data concerning HAIs are often siloed within individual institutions, and data-sharing is rare. However, there are some notable exceptions that indicate the feasibility of large-scale monitoring and surveillance in India. From 2004 to 2013, 40 Indian hospitals in 20 cities participated in a large-scale, long-term HAI surveillance project, conducted by the INICC. As previously described, the hospitals successfully implemented standardised surveillance methods, using U.S. National Healthcare Safety Network criteria to establish HAI levels in the Indian sites.[12]

Expanding this type of standardised monitoring and reporting nationally could help to quantify the HAI problem in India, thereby enabling healthcare facilities to



tackle it more effectively. However, there have already been several notable efforts towards infection control, including one project aimed at reducing the incidence of CLABSIs in 16 ICUs in 11 hospitals across 8 Indian cities.

The healthcare workers in these hospitals implemented several best-practice approaches, including hand-washing protocols, safer and reduced use of central lines, regular dressing changes, and disinfection of equipment. Staff received additional training and performed standardised surveillance to measure baseline and post-intervention rates of CLABSIs. The intervention achieved a striking 53% reduction in the CLABSI rate, which was maintained for at least 36 months after the project.[30] A similar intervention to reduce VAP rates in 21 ICUs in 10 Indian cities resulted in a 38% reduction.[31]

These studies show that it is possible to successfully reduce HAIs in Indian healthcare facilities by implementing surveillance and infection-control strategies. These small-scale efforts are encouraging; however, nationwide surveillance efforts are needed to effectively inform policy changes for the tackling of HAIs in India.

The Indian authorities have already started some encouraging initiatives. The Indian Council of Medical Research started a laboratory network in 2013 to monitor antimicrobial resistance, as part of a five-year national action plan on antimicrobial resistance launched by the Indian Ministry of Health and Family Welfare.[32] So far, the network consists of 25 hospital laboratories that report on antibiotic-resistant bacteria and their susceptibility to various antibiotics. Although this system is still in its infancy, it is a step in the right direction, and there are plans to expand it and build on these initial successes.

5 Future management of HAIs in India

Reducing the number of HAI cases in India is an achievable and worthwhile goal. As the HAI burden in India is significant, infection control programmes will yield enormous benefits for patients and healthcare workers alike. Programmes around the world have shown that the burden of HAIs can be reduced by 50% or more, and many effective infection-control strategies are simple and inexpensive, largely only requiring a change in healthcare culture. Although guidelines are helpful, strictly enforced policies are likely to have a much greater impact. This section covers some potential strategies, with a particular focus on enforceable policy changes that will make a significant difference.

5.1 Cleanliness, hygiene and sanitation

HAIs can erode patient confidence in the healthcare system and make patients feel less secure when undergoing treatment. Maintaining adequate sanitation and cleanliness is crucial in reducing HAI numbers in Indian healthcare facilities. Clean, sanitary healthcare facilities and between-patient diagnostic device decontamination improve patient safety and security, and are a basic prerequisite for quality healthcare.

Adequate sanitation includes the prompt removal of medical waste and soiled material, and the regular cleaning of surfaces, equipment, gowns and bed linen. Basic cleaning to remove foreign material from surfaces should be followed by the use of disinfectants to decontaminate and kill surface microbes. However, the time and effort spent cleaning and disinfecting can be largely wasted if substandard cleaning and disinfectant products are used. Disinfectants that work in the presence of organic matter (such as blood) should have excellent biocidal properties and be non-corrosive to materials commonly used in fixtures and fittings and medical equipment, as well as being non-adhering.[33] There have been numerous reports in the medical literature of patients experiencing anaphylactic shock from traces of disinfectant products left on the surface of the medical devices they were intended to clean. Therefore, adhering disinfectants, or those not fully rinsed off surfaces they were intended to clean, can be dangerous coming into

contact with mucosal surfaces in the human body and veterinary patients.

This is particularly important for high-level disinfectant solutions used to properly clean, disinfect and decontaminate invasive medical devices. These devices encompass anything that contacts a mucous membrane or other internal tissues. This includes in-dwelling catheters and breathing tubes, and basic surgical tools, such as scalpels and forceps, as well as more advanced equipment, such as endoscopes. Invasive medical devices provide a ready access point for microbes to enter the body, and are associated with a variety of serious HAIs.[17]

Therefore, adequately cleaning and sterilising invasive medical equipment before use is essential in preventing HAIs. As high-level disinfectant cleaning solutions are regulated as medical devices themselves, they must perform to very high standards with efficacy and safety. Substandard cleaning products that fail to adequately disinfect invasive devices put patients at considerable unnecessary risk of acquiring an HAI.

"Surveillance programmes are an extremely important component of effective nationwide infection-control efforts".

The testing of hospital cleaning products, both prior to market introduction and while on the market in India, should use a recognised standard developed by independent laboratories, as part of a pre- and post-marketing surveillance programme. Cleaning invasive medical devices and exposing hospital surfaces to contact cleaning agents that weaken but do not kill super bugs only encourages those pathogens to become stronger, and exposes the hospital community unnecessarily to potential illness from an HAI.

Policies that incentivize Indian hospitals to adhere to basic hygiene and sanitation practices will yield significant dividends in reducing HAIs, particularly for sensitive practices, such as high-level disinfection of invasive devices.

5.2 HAI surveillance policies

Surveillance is defined as "the ongoing, systematic collection, analysis, and interpretation of health data, closely integrated with the timely dissemination of these data to those who need to know". Surveillance programmes are an extremely important component of effective nationwide infection-control efforts.

If the scale of a problem is unknown, there is little hope of solving it. By initiating mandatory nationwide surveillance efforts, policymakers can identify problem areas and assess if infection-control interventions are working. Policymakers could also commission specific research into the risk factors for HAIs that are distinct to the Indian healthcare system, helping to shape future policies and initiatives to combat HAIs.[1]

Surveillance enables hospitals to see where they rank compared to other hospitals, increases staff awareness of HAIs, and encourages staff to reduce HAI levels. There are presently no formal nationwide surveillance

programmes operating in India. Individual hospitals may record their own data, but these figures are typically not shared, and there is a lack of transparency. Policies that incentivize Indian hospitals to accurately collect and share HAI data in a standardised way are essential to quantify HAI levels.

Surveillance programmes should ideally adhere to best practice in terms of internationally-accepted protocols; however, it is also important to design and validate affordable programmes based on the reality of Indian healthcare facilities. The Indian healthcare system varies significantly in terms of the resources available to different healthcare facilities. Sophisticated HAI surveillance approaches can be technically demanding and time-consuming, posing a challenge for low-resource healthcare facilities.

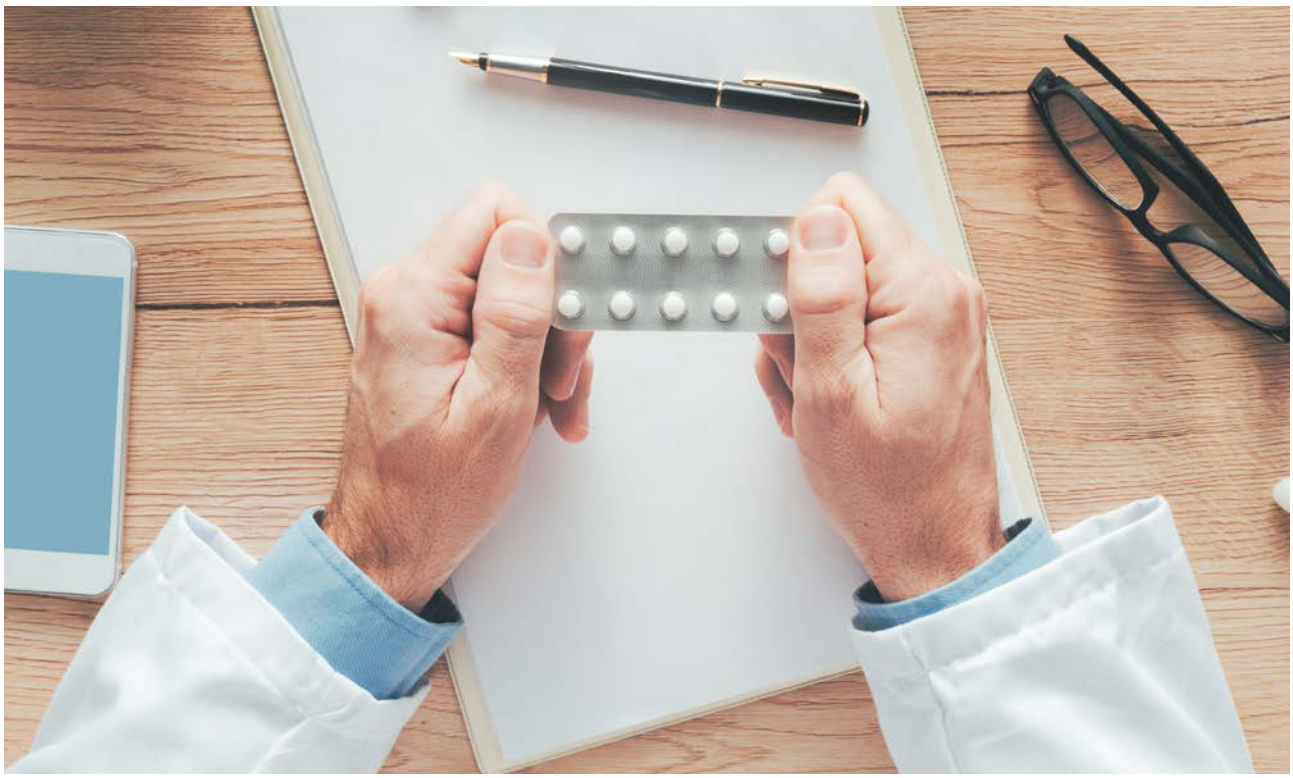
Surveillance programmes can be adapted to suit challenging healthcare conditions. Policymakers commissioning research into the most suitable surveillance approaches for the Indian healthcare system will maximise the chances of a successful programme. For example, in understaffed and overcrowded healthcare facilities, patients and family members could be instructed to recognise and report obvious signs of infection to help with surveillance.[8] Passive surveillance techniques, which gauge HAI levels based on routinely recorded patient symptoms and laboratory results, may be best suited to low-resource facilities.[1]

5.3 Infection control training and accountability

One of the most effective ways to address HAIs is to implement specific HAI training programmes for healthcare staff. This includes providing new training programmes for existing staff and adding HAI-specific information to the training curriculum for new staff. Staff training can help to increase awareness of HAIs and can empower staff to implement low-cost, evidence-based practical solutions to reduce them.

Many basic infection control measures are simple, inexpensive and largely achievable through behavioural changes. These techniques include maintaining appropriate hand hygiene, using gloves, correctly disposing of needles and contaminated waste, refraining from reusing soiled equipment, and ensuring that hospital rooms and equipment are routinely disinfected.[34] Training interventions can be very effective. For example, a simple staff intervention in three Indian hospitals increased adherence to hand-hygiene protocols from 36.9% to 82%.[35]

Increasing staff accountability is also a key component of



long-term behavioural change. This includes monitoring staff performance, providing feedback on performance, and supplying incentives or enforcing penalties depending on staff behaviour during work. If an HAI occurs, staff should be involved in determining if there has been a failure in best practice. New policies could make such education and accountability systems mandatory in the Indian healthcare system.

5.4 Antibiotic stewardship policies

The responsible and judicious use of antibiotics to maximise treatment effectiveness and reduce the risk of antibiotic resistance is called antibiotic stewardship. Unfortunately, antibiotics are frequently misused and overused in India. The overuse of antibiotics contributes to antibiotic resistance and serious HAIs. Policies that increase surveillance and restrictions on antibiotic use will help to combat this phenomenon.

Specific training programmes for hospital and community healthcare staff on antibiotic stewardship will help to reduce dangerous HAIs. Policies that restrict the inappropriate prescription of antibiotics, over-the-counter sales of antibiotics and excessive use of antibiotics in agriculture are also essential to reducing antibiotic resistance and associated HAIs.[36]

5.5 Economic policies to combat HAIs

Reducing HAIs could save Indian hospitals a significant amount of money and help to offset the cost of infection control programmes. A study into the economics of reducing healthcare-acquired conditions in the U.S. concluded that the cost of patient harm significantly outweighed the cost of preventing it, with a 21% decline in healthcare-acquired conditions (including significant reductions in HAIs) between 2010 and 2015 resulting in savings of approximately $28 billion.[37]

Hospitals, however, may need additional motivation to participate in nationwide infection control initiatives. Policies that impose financial incentives and penalties on individual hospitals could be highly effective in reducing HAI levels. Such measures would encourage hospital compliance with HAI surveillance programmes. By setting HAI reduction targets, underperforming hospitals could be financially penalised, whereas high performing hospitals could receive a financial bonus.

Other policies that could incentivise reductions in HAI levels include banning private hospitals from passing the cost of HAIs on to their patients. The U.S. government insurer has, for example, refused to reimburse hospitals for certain conditions that were not present on admission. This means that such hospitals must pay to treat patients with certain HAIs, creating a strong incentive to reduce HAI levels.[15]

Conclusion

Describing the scale and scope of HAIs in India is a formidable challenge. The contributing factors in India are numerous, with a lack of substantial government policy being the centralised issue.

This paper outlines actions health policymakers can take to tackle the challenges that all healthcare facilities face in providing safe, secure and quality healthcare.

Considering the daunting task of the future management of HAIs in India, this paper recommends the following measures:

- Implement guidelines on thresholds of effectiveness for various hospital cleaning products. Cleanliness, hygiene and sanitation underpin techniques to prevent HAIs. Policymakers must be able to review existing marketed products and their effective use in order to facilitate a secure, high-quality healthcare system.
- Expand the INICC long-term HAI surveillance programme nationally. By being able to properly quantify HAI parameters, the MoH will be in a better position to set targets and tackle offending areas
- Introduce rigorous infection-control training for all hospital staff, not just medical staff. Increase staff accountability, with internal and external programmes of recognition as incentives.
- Encourage antibiotic stewardship programmes, extending accredited drug-dispensing qualifications to local villages.
- Impose financial incentives and penalties for hospitals relating to the above interventions to achieve reductions in HAIs and make better use of hospital assets.

Understanding, monitoring and preventing HAIs is key to bringing the healthcare system in India forward to align with the developed world and protect its citizens from preventable harms.

References

1. World Health Organisation. Report on the Burden of Endemic Health Care-Associated InfectionWorldwide: a systematic review of the literature. 2011. Available from:
http://apps.who.int/iris/bitstream/handle/10665/80135/9789241501507_eng.pdf;jsessionid=0C0D2A6E79ACDA59FA1C206C487CD8A3?sequence=1

2. Cardoso T, Almeida M, Friedman ND, Aragão I, Costa-Pereira A, Sarmento AE, Azevedo L. Classification of healthcare-associated infection: a systematic review 10 years after the first proposal. BMC medicine. 2014 Dec;12(1):40.

3. Ministry of Health and Family Welfare, Government of India. National Guidelines for Clean Hospitals. 2015. Available from: https://mohfw.gov.in/sites/default/files/7660257301436254417_0.pdf

4. Centers for Disease Control and Prevention. Acute Care Hospitals National Factsheet. 2017. Available from:
https://www.cdc.gov/hai/pdfs/acute-care-hospitals-national-factsheet_508.pdf

5. OECD/EU. "Healthcare-associated infections" in Health at a Glance: Europe 2016: State of Health in the EU Cycle. 2016. Available from:
https://read.oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-europe-2016_9789264265592-en - page1

6. European Centre for Disease Prevention and Control. Healthcare-associated infections acquired in intensive care units: Annual Epidemiological Report for 2016. Available from:
https://ecdc.europa.eu/en/publications-data/infections-acquired-intensive-care-units-annual-report-2016

7. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, Lynfield R, Maloney M, McAllister-Hollod L, Nadle J, Ray SM. Multistate point prevalence survey of health care–associated infections. New England Journal of Medicine. 2014 Mar 27;370(13):1198-208.

8. Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L, Pittet D. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. The Lancet. 2011 Jan 15;377(9761):228-41.

9. Bammigatti C, et al. Healthcare associated infections in a resource limited setting. Journal of Clinical and Diagnostic Research. 2017 11.1.

10. Ramasubramanian V et al. Epidemiology of healthcare acquired infection – An Indian perspective on surgical site infection and catheter related blood stream infection. Indian Journal of Basic and Applied Medical Research. 2014 3(4):46-63.

11. Rosenthal VD. Central line-associated bloodstream infections in limited-resource countries: a review of the literature. Clinical Infectious Diseases. 2009 49(12):1899-907.

12. Mehta Y, Jaggi N, Rosenthal VD, Kavathekar M, Sakle A, Munshi N, Chakravarthy M, Todi SK, Saini N, Rodrigues C, Varma K. Device-associated infection rates in 20 cities of India, data summary for 2004–2013: findings of the International Nosocomial Infection Control Consortium. Infection Control & Hospital Epidemiology. 2016 Feb;37(2):172-81.

13. Zimlichman E et al. Health care-associated infections: a meta-analysis of costs and financial impact on the US health care system. JAMA Internal Medicine. 2013 Dec;173(22):2039-46.

14. Stone PW. Economic burden of healthcare-associated infections: an American perspective. Expert Review of Pharmacoeconomics and Outcomes Research. 2009 Oct;9(5):417-22.

15. Reed D, Kemmerly SA. Infection control and prevention: a review of hospital-acquired infections and the economic implications. The Ochsner Journal. 2009 Mar;9(1):27-31.

16. Su CH, Chang SC, Yan JJ, Tseng SH, Chien LJ, Fang CT. Excess mortality and long-term disability from healthcare-associated Staphylococcus aureus infections: a population-based matched cohort study. PLoS One. 2013 Aug 6;8(8):e71055.

17. Rosenthal VD et al. Device-associated nosocomial infections in 55 intensive care units of 8 developing countries. Annals of Internal Medicine. 2006 Oct 17;145(8):582-91.

18. Joyce S et al. Surgical Site Infections: Assessing risk factors, outcomes and antimicrobial sensitivity patterns. African Journal of Microbiology Research. 2009 Apr;3(4):175-179.

19. Centers for Disease Control and Prevention. National and State Healthcare Associated Infections: Progress Report. 2016. Available from: https://www.cdc.gov/HAI/pdfs/progress-report/hai-progress-report.pdf

20. The White House — Obama Administration. National Action Plan for Combating Antibiotic-Resistant Bacteria. 2015. Available from:
https://obamawhitehouse.archives.gov/sites/default/files/docs/national_action_plan_for_combating_antibotic-resistant_bacteria.pdf

21. The White House — Obama Administration. Executive Order — Combating Antibiotic-Resistant Bacteria. 2014. Available from:
https://obamawhitehouse.archives.gov/the-press-office/2014/09/18/executive-order-combating-antibiotic-resistant-bacteria

22. World Health Organization. World Health Assembly resolution 67.25. Antimicrobial Resistance. 2014. Available from:
http://apps.who.int/gb/ebwha/pdf_files/WHA67/A67_R25-en.pdf?ua=1&ua=1

23. Centers for Disease Control and Prevention. Interim Guidance for a Health Response to Contain Novel or Targeted Multidrug-resistant Organisms (MDROs). 2015. Available from:
https://www.cdc.gov/hai/containment/guidelines.html

24. Dick A et al. A decade of investment in infection prevention: A cost-effectiveness analysis. American Journal of Infection Control. 2015 Jan;43(1):4-9. Journal Infection Control. 2015 Jan;43(1):4-9.

25. Institute for Healthcare Improvement. What Zero Looks Like: Eliminating Hospital-Acquired Infections.
2015. Available at:
http://www.ihi.org/resources/Pages/ImprovementStories/WhatZeroLooksLikeEliminatingHospitalAcquiredInfections.aspx

26. Calikoglu S et al. Hospital pay-for-performance programs in Maryland produced strong results, including reduced hospital-acquired conditions. Health Affairs (Millwood). 2012 Dec;31(12):2649-58.

27. Septimus E, Weinstein RA, Perl TM, Goldmann DA, Yokoe DS. Approaches for preventing healthcare-associated infections: go long or go wide?. Infection Control & Hospital Epidemiology. 2014 Jul;35(7):79-801.

28. Vos MC et al. 5 years of experience implementing a methicillin-resistant Staphylococcus aureus search and destroy policy at the largest university medical center in the Netherlands. Infection Control & Hospital Epidemiology. 2009 Oct;30(10):977-84.

29. Robicsek A, Beaumont JL, Paule SM, Hacek DM, Thomson RB, Kaul KL, King P, Peterson LR. Universal surveillance for methicillin-resistant Staphylococcus aureus in 3 affiliated hospitals. Annals of Internal Medicine. 2008 Mar 18;148(6):409-18.

30. Jaggi N et al. Impact of an international nosocomial infection control consortium multidimensional approach on central line-associated bloodstream infection rates in adult intensive care units in eight cities in India. International Journal of Infectious Diseases. 2013 Dec;17(12):e1218-24.

31. Mehta Y et al. Effectiveness of a multidimensional approach for prevention of ventilator-associated pneumonia in 21 adult intensive-care units from 10 cities in India: findings of the International Nosocomial Infection Control Consortium (INICC). Epidemiology and Infection. 2013 Dec;141(12):2483-91.

32. Swaminathan S, Prasad J, Dhariwal AC, Guleria R, Misra MC, Malhotra R, Mathur P, Walia K, Gupta S, Sharma A, Ohri V. Strengthening infection prevention and control and systematic surveillance of healthcare associated infections in India. BMJ. 2017 Sep 5;358:j3768.

33. Centers for Disease Control and Prevention. Guideline for Disinfection and Sterilization in Healthcare Facilities. 2008. Available from: https://www.cdc.gov/infectioncontrol/pdf/guidelines/disinfection-guidelines.pdf

34. Chugh TD. Hospital Infection Control—Are We Serious?. Medical update. 2012. 22:74-77.

35. Chakravarthy M et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. Journal of Infectious Public Health. 2015 Mar;8(2):177-86.

36. Global Antibiotic Resistance Partnership (GARP)-India Working Group. Rationalizing antibiotic use to limit antibiotic resistance in India. The Indian Journal of Medical Research. 2011 Sep;134(3):281.

37. OECD Health. The economics of patient safety. 2017. Available from:
https://www.oecd-ilibrary.org/social-issues-migration-health/the-economics-of-patient-safety_5a9858cd-en

Addendum Table

Typical HAI data obtained through nationwide surveillance programmes

	Overall number of hospitalised patients who develop an HAI	Proportion of hospitalised patients that develop an HAI	HAI-related mortality	Estimated HAI-related costs	Role of medical devices in HAIs	Progress in reducing HAIs	Most common types of infection
	1.7 million	4.5%	100,000 deaths annually	$28 billion-45 billion annually	e.g. 87% of bloodstream infections occurred in patients fitted with a central line	e.g. 50% decrease in CLABSI between 2008 and 2014	Pneumonia (21.8%), surgical-site infections (21.8%), gastrointestinal infections (17.1%)
	4.13 million	5.9%	110,000 deaths annually	€7 billion annually	e.g. 97% of ICU urinary tract infections involve a urinary catheter	e.g. decrease from 3.6 CLABSI episodes per 1000 central line days in 2008 to 3.0 in 2012	Surgical site infections (19.6%), pneumonia (19.4%), urinary tract infections (19.0%)
							

These figures are a snapshot of some of the HAI data collected by countries and regions. These data help legislators to identify problem areas, develop infection control programmes and reduce HAI levels. Such data are typically subdivided using a variety of categories, including region, territory, hospital type, patient type, etc.

HAI reporting depends heavily on how HAIs are defined and diagnosed. For instance, infections that present at home after a period of hospitalisation may or may not be classified as HAIs, depending on the criteria applied in a particular country or region. This makes comparisons between countries difficult, and confirms the need for