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Infection Prevention and Safety in Low and Middle Income Countries (S Sengupta, Section Editor)

Opportunities to Overcome Implementation Challenges of Infection Prevention and Control in Low-Middle Income Countries

Sharmila Sengupta, MD[1,*]
Purabi Barman, MD[2]
Jamie Lo, MPH[1]

Address
[*,1]Department of Infectious Diseases, National Center for Infectious Diseases, Tan Tock Seng Hospital, 16 Jln Tan Tock Seng, Singapore, 308442, Singapore
Email: sharmila.sengupta1211@gmail.com
[2]Department of Clinical Microbiology, BL Kapoor Hospital, Pusa Road, New Delhi, 110005, India

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Abstract

Purpose of review Healthcare-associated infections (HAIs) and rising antimicrobial resistance (AMR) have posed a major challenge in patient care across the globe, more so in lower-middle-income countries (LMICs). Studies have shown that implementation of an effective infection prevention and control (IPC) program reduces incidence of HAI to a large extent. However, implementation of such a program in low-resource setting has many challenges. Research have shown that gaps exist due to absence of political will, trained manpower, and alternate healthcare priorities.

Recent findings With progress in science of healthcare epidemiology and digital communication, opportunities to establish an effective IPC program at minimal cost is possible. In this review, we explore ways the existing challenges can be mitigated in LMICs. In recent times, the UN general assembly along with World Health Organization (2015) and member countries took a resolution to come up with an action plan to tackle the rising threat of AMR by strengthening IPC programs at national level.

Summary We reviewed the progress made by the developing countries in their efforts to implement the program.

Introduction

Across the globe, healthcare-associated infections (HAIs) pose a major concern in all healthcare systems. It contributes significantly to patient morbidity and mortality particularly in low- and middle-income countries (LMICs). The prevalence is generally higher (> 40%) than that in high-income countries (HICs) (3.5–12%) and has major economic consequences [1].

"Low-middle income countries" are classified by the World Bank according to their economies and Gross National Income (GNI) per capita (World Bank Atlas method). For the current 2019 fiscal year, low-income economies are those with a GNI per capita of $995 or less in 2017; lowe-middle-income economies are those with a GNI per capita between $996 and $3895 [2]. LMICs include about 147 countries in Latin America, Sub-Saharan Africa, South Eastern Europe, and major parts of Asia—Pacific (barring countries such as Japan, Taiwan, South Korea, Singapore, Australia, and New Zealand) [3].

The magnitude of the problem remains underestimated or largely unknown because diagnosis is complex and surveillance activities to guide interventions are minimal in these countries. The most recent estimates in developing countries found the prevalence of HAI to be 15.5 per 100 patients (95% CI 12.6–18.9) [4]. A survey conducted by the World Health Organization (WHO) in 2010 states that only 15.6% of developing nations reported a functioning national surveillance system. Intensive care unit (ICU)–acquired infections were as high as 35.2% (95% CI 24.2–48.0) (pooled cumulative incidence) and device-associated infection densities are up to 13 times higher than those in developed countries like the USA [5]. Gap analysis of infection prevention and control (IPC) practices across six international sites in LMICs shows adherence to recommended practices is suboptimal. Opportunities for improvement exist in several areas including regulatory mechanisms, guidelines and policies, hospital wide IPC programs, surveillance, antibiotic stewardship, and improved hand hygiene [6].

Current challenges in reducing healthcare-associated infections in low- and middle-income countries

Infection prevention and control

Few studies have addressed the gaps existing for accomplishing a strong foundation to reduce risks and spread of healthcare-associated infections [7•, 8, 9]. The common challenges such as competing political agendas, resource constraints, lack of trained personnel, and lack of surveillance data have always remained a barrier. Additionally, despite strong evidence for the effectiveness of IPC, further research is needed to identify and validate innovative technologies, cost-effectiveness of interventions, feasible implementation approaches and local solutions for low-resource settings [10].

Surveillance of healthcare-associated infections (HAIs) is the cornerstone of an effective infection prevention program. However, surveillance systems are almost non-existent in LMICs because of social and healthcare system deficiencies. Additionally, overcrowding, understaffed hospitals, inadequate IPC practices, lack of policies/guidelines and trained professionals add to the extent of the problem [11]. Healthcare workers (HCWs) lack knowledge regarding safe

practices, risk of transmission of HAI, and hospital waste management [12].

Antimicrobial resistance

Antimicrobial resistance (AMR) is not a recent phenomenon but has become a critical threat to the human population. A recent development, and cause of concern, is an apparent shift in the burden of AMR occurring between the main classes of pathogens from Gram-positive to Gram-negative bacteria [13] and *Candida auris*—an emerging multidrug-resistant yeast that can cause invasive infections, which is associated with high mortality, and spreads in healthcare settings [14]. This could rather stretch the already limited resources of health services as resistant Gram-negative pathogens will soon outweigh the achievements in reduction of resistant Gram-positive pathogens. Carbapenem-resistant Enterobacteriaceae (CRE) has left very few options for treatment. Colistin, which is considered as the "last resort" drug in CRE, has also shown resistance in clinical isolates. Reports from Greece, Italy, China, Turkey, and India are documented evidence [15–20]. Recent study published from India finds high levels of mortality due to colistin-resistant bacterial infections [21]. Lack of antibiotic policy, self-medication, over the counter availability of cheap substandard, counterfeit antimicrobials, and unregulated usage all contribute to prevalence of resistance in these countries. Maximum numbers of counterfeit drugs are found in Asia and Africa [22–24]. All these factors together contribute to the rising and spread of AMR across the world.

Available opportunities to improve infection prevention and control in low-middle-income countries

Prevention and control of HAI is an increasingly important element in improving healthcare more so in LMICs. Here, we would like to discuss the opportunities which are available to resource-limited settings, for implementation of an IPC program which includes antimicrobial stewardship.

It is to be noted that effective infection control does not require expensive resources and can be implemented with minimal cost [25, 26]. It is just as feasible to institute appropriate IPC practices in low-resource settings as in high-resource settings. It requires strategic approach, clinical leadership, and administrative will, and is based on commonsense, sound knowledge of procedures, and safe practices.

The core components of IPC as categorized by the WHO are applicable to most healthcare settings [27•]. It is multidisciplinary and multi-modal but inter-related collectively, and can be woven into a network of hospitals, regions, and countries both in high- and low-resource settings, thus adding value to stakeholders responsible for policy making and/or implementation [28••].

Core components

1. IPC program
2. IPC guidelines
3. IPC education and training

4. Surveillance
5. Multimodal strategies
6. Monitoring/audit of IPC practices and feedback
7. Workload, staffing, and bed occupancy (acute healthcare facility only)
8. Build environment, materials, and equipment for IPC at the facility level (acute healthcare facility only)

IPC Program

The first step in this direction is planning an infection prevention and control (IPC) program. IPC will vary according to the size and scope of the organization. There are three essential and fundamental concepts to the program: (i) mission statement which is the reflection of the needs to be addressed by the program; (ii) vision which describes the future goals of the IPC program for the organization; and (iii) core values that serve as the blueprint of the program and indicate how the program functions on daily basis [29].

Resources for IPC guidelines

The electronic media and satellite communication has been a great boon to healthcare in this millennium. A large body of resources and knowledge on infection prevention are available and accessible through the internet. The evidences from studies done in developed countries such as the USA (CDC, NHSN, AHRQ, IHI), the UK (NICE guidelines), EU, and Australia are available and can be adapted and customized to LMICs. The basic principles of infection prevention being the same, the applicability of all methods maybe difficult in resource-limited settings, where innovation is the key. Multiple tools have been developed for the assessment of infection control by the WHO and the USAID (Agency for International Development). The Infection Control Assessment Tool (ICAT) aims to identify targets for improved IPC practice which can be accessed easily [30]. However, it should be remembered that standards set by developed countries are often unachievable in LMICs due resource limitations, institutional priorities, and lack of expertise [31]. More studies need to be conducted, to ascertain appropriate, available, accessible, affordable, and applicable tools for low-resource settings to bridge the existing gap.

IPC education, training, and research

The presence of policies and guidelines does not necessarily ensure implementation in resource-limited settings. Introduction of structured curricula in medical and nursing education and in-house training of healthcare workers (HCWs) through workshops and CMEs will help in capacity building [32–34]. An area of opportunity lies in translation of international guidelines into simple local languages, which can be followed by ground-level HCWs in their day-to-day practices. Utilization of communication technology is an easy and affordable way to disseminate knowledge on IPC

and AMR among HCWs, patients, and public.

Research requires funding and expertise. Funding of research by high-income countries in LMICs will be a good opportunity to curb infectious diseases, which knows no borders [35]. There have been a good number of studies to show the cost-benefit of an IPC program in high-income countries [36]; however, such studies are required in low-resource settings. LMICs offer great potential for research in exploring epidemiology, pathogenesis, transmission, prevention, and economics of HAI. Among its efforts in this field, the WHO coordinates the Global IPC (GIPC) Network, which brings together major IPC organizations with the aim of enhancing local, national, and international collaboration [10].

HAI surveillance and sharing of data remain key issues for infection prevention and control program as have been proved since 1985 by the SENIC study [37] and confirmed by recent reviews [38]. An option for resource-limited settings is implementation of periodic point prevalence survey (PPS) [39] compared to incidence studies, which require many more resources. PPS allows researchers to survey larger numbers of hospitals, even when human resources are limited. The existing gap of incidence studies which remain a reference for HAI description and understanding, the existing gap can be partially controlled by PPS repeated at defined intervals. The European Centre for Disease Prevention and Control (ECDC), within the framework of the "Antimicrobial resistance and healthcare-associated infection" program, developed and implemented multiple surveillance networks (starting from 2011 to 2012), conducting PPS for the detection of HAIs and antimicrobial use (AU) in acute hospitals [40]. A recent PPS study done in Italian hospitals shows this approach, guarantees a benchmark, and gives to the single hospital the opportunity to further improve its IPC program [41•]. Designing appropriate focus area of surveillance can be customized according to the individual healthcare settings and available resources following standard guidelines. In addition, surveillance information systems allow better "antibiotic resistance monitoring" and "antimicrobial use" helping to provide evidence-based results that can be used for the development of policies [42].

Strengthening laboratory capacity

The microbiology laboratory plays a key role in success of a strong IPC by making data accessible. The design of the laboratory's record-keeping system if developed in collaboration with the infection control team accommodates the needs of the IPC program. Surveillance data should be regularly reported and shared at the regional and global levels [43]. There is also an urgent need to build laboratory capacity for ensuring reliable and rapid test results. Based on which, prescribing decisions and infection prevention measures can be taken. The use of technology such as electronic health records (EHR) and free microbiology software such as WHONET is great boon to LMICs where dearth of trained manpower is a formidable hindrance [44]. Basic hospital laboratories should be able to conduct appropriate sampling of specimens, culture for identification, and susceptibility for immediate patient care. Linking reference laboratories for epidemiological surveillance is a possible method to overcome high-end

molecular testing. This enables obtaining reports on prevalence and spread antimicrobial resistance, detection of outbreaks, use of quality surveillance data for continuous improvement [45]. Point of care test (POCT) services can be used. These are low-cost tests, which do not need sophisticated instruments or skilled manpower and are easy to operate with a rapid turnaround time [46].

The scope of accreditation by national/international bodies also gives an opportunity to develop the IPC program, as it is one of the essential components of accreditation. Studies have shown accreditation to be positively associated with the establishment of organizational structures and processes, promotion of quality and safety cultures, improvements in patient care, and professional development being key benefits [47]. Unlike high-income countries where accreditation of healthcare is mandatory, many healthcare institutions in developing countries opt for the recognition through accreditation. This gives a competitive edge over other non-accredited hospitals in terms of profit and attracting paying patients.

The WHO's proposal for making the IPC a multi-modal, multi-disciplinary program enables low-resource settings to be more flexible and encourage team work and sharing the burden [28••]. This fosters inclusiveness, ownership and sense of responsibility, and scope to all healthcare workers to participate and make it successful [48].

Monitoring/audit of IPC practices and feedback

Monitoring, audit, and feedback are important tools to spread awareness among healthcare workers, in achieving attitudinal change, besides engaging stakeholders in creating working partnerships in improving patient services. Audit and feedback generally lead to small but potentially important improvements in professional practice [49]. A feedback and feed-forward cycle is a major tool for positive reinforcement and encourages healthy competition and active participation of individuals, within healthcare organizations.

Workload, staffing and bed occupancy(acute care facility only)

The WHO workload indicators and staffing needs provides a guide to healthcare managers in planning and distributing workload according to available manpower and resources [50]. Leaders of health systems must take the initiative to maximize the effectiveness of these programs by aligning them and funding them adequately [51•]. Ushering a culture change is more of perseverance and examples set by leaders in the organization and does not require heavy investments. Identifying motivated persons and empowering them to run the program lie in the hands of the administration. The challenge is in taking advantage of communication technology to train identified healthcare workers in the implementation of policies. Most important of all is to bring in a positive change of attitude and behavior among all HCWs towards the concept of prevention of HAI. Increase in hand hygiene compliance is the best example of bringing change in behavior of healthcare workers through perseverance and positive feedback [52].

Motivated key individuals if identified as champions can play a significant role in bringing change. Active champions influence organizational change through four functions: (i) building organizational support for new practices; (ii) protecting those involved in implementation from organizational rules and systems that may be barriers; (iii) helping to access the use of organizational resources for implementation; and (iv) supporting the growth of organizational coalitions to achieve implementation [53]. Champions are often well respected within organizations for their knowledge, skills, and interpersonal styles, and have the capacity to influence both the administration and the ground-level healthcare workers [54].

Build environment, materials and equipments for IPC at the facility level (acute care facility only)

Identifying areas of high-risk for infections within the healthcare (e.g., OTs, ICUs, Labs) and providing with basic infrastructure, equipment, and materials such as hand hygiene products, masks, gloves, and gowns also promote a change in culture towards safe practices. Protocols for appropriate use need to be in place for better utilization and prevention of misuse and wastage [55, 56].

Recent global efforts to facilitate infection prevention and antimicrobial resistance

The UN General Assembly along with representatives from the WHO and representatives from member countries took a resolution on tackling the rising threat of antimicrobial resistance and urged to come up with an action plan by 2017–2018. Implementation of IC practices and antimicrobial stewardship in humans, animals, food, and agriculture (One Health) is essential for achieving the goal. Countries reaffirmed their commitment to develop national action plans on AMR (Fig. 1). Based on the *"Global Action Plan on Antimicrobial Resistance"*—the blueprint for tackling AMR developed in 2015 by the WHO [57]. Since then, many countries have attempted to establish IPC programs with varying degrees of success [58, 59]. Countries like India with high burden of antimicrobial resistance have committed to come up with a national action plan [60–62]. Other initiatives, such as the Global Antibiotic Resistance Partnership (GARP) and the Global Health Security Agenda (GHSA), also aim to assess and improve national capacity for combatting AMR. GARP, a project of the Center for Disease Dynamics, Economics & Policy (CDDEP), supports local creation of AMR policy by providing guidance, tools, and technical support to local researchers and policymakers, and is currently functioning in several LMICs [63, 64].

Latest update from the World Health Assembly (23 May 2019) says that "Member states agreed a resolution calling for high-level commitments to implement and adequately resource multi-sectorial National Action Plan to strengthen infection prevention and control measures including water

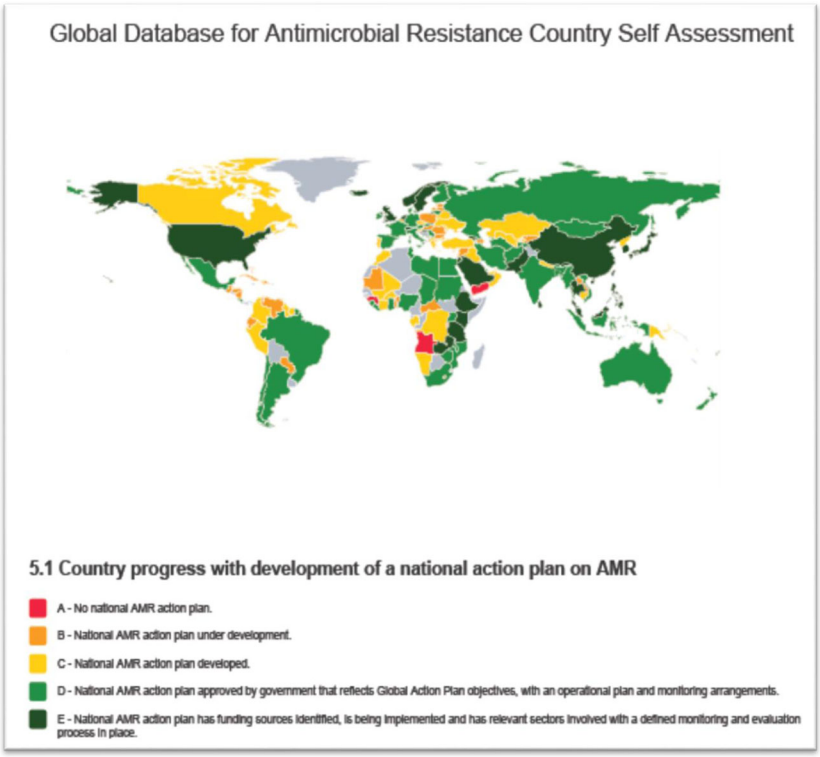

Fig. 1. Country progress with development of national action plan on AMR (courtesy: WHO).

sanitation and hygiene; enhance participation in Global Antimicrobial Surveillance System (GLASS); ensure prudent use of quality-assured antimicrobials; and support multi-sectorial annual self-assessment survey" [65].

Events such as worldwide infectious disease outbreak of SARS/Mers-coV/Ebola in recent years became an important impetus for authorities in identifying gaps and providing opportunity to start IPC programs in affected countries. Such incidence has seen to trigger planning and implementation of IPC at national levels, creating awareness in health ministries for allocation of funds, leading to development of policies, improvement of infrastructure, and education of healthcare workers resulting in safer healthcare practices [66, 67].

Ongoing efforts in infection prevention in LMICs

Latin America

A recent study of 8 Latin American countries showed prevalence of patients with HAI was 11.6% (90/771; 95% CI 9.3–14). Of all HAIs, 67% were VAP, 18% were bloodstream infections, 13% were SSI, and 10% were UTI. Similar prevalence was observed in other Latin American ICUs (27% and 23.2% in Argentina and Mexico, respectively). However, lower observed rates in the study might be due to lower sensitivity of diagnosis of infections made by sometimes insufficiently trained ICPs [68]. Countries like Chile and Venezuela have had ministry of health regulations since 1982 and

1984; however, the implementation has been suboptimal, whereas there is good surveillance system in the hospital environment in Jamaica and the Caribbean islands [69].

Eastern Europe

IPC in these countries is in midst of transition. Countries such as those formerly in the United Soviet Socialist Republic (USSR), Mongolia, and post-conflict Eastern Europe are in their first stages of reform. Poor commitment, resource scarcity, and shortages of expertise exist. Underreporting of official infection control statistics is widespread. An example is in in Mongolia (located between Russia and China) wherein the Government approved a national program on sentinel surveillance system for HAIs in 2002 but implementation has been delayed due to insufficient support from stakeholders and shortages of resources and trained infection control professionals [70].

Egypt

Egypt established a national infection control program in 1999 [71]. During the last decade, while IPC activities were progressing in Egypt, a plan to implement a nationwide HAI surveillance program in intensive care units (ICUs) was developed with support from several partners: the U.S. Centers for Disease Control and Prevention's (CDC's) Global Disease Detection (GDD) Program in Egypt, the U.S. Naval Medical Research Unit (NAMRU-3), and the U.S. Agency for International Development in Egypt. The target was to implement the surveillance program in all hospitals with ICUs before September 2018. Implementation of a sustainable surveillance system in a resource-limited country was possible following a stepwise approach with continuous evaluation. Enhancing IPC programs is now an infection control priority in Egypt [72].

Sub-Saharan Africa

Very little information is available on the epidemiology of HAI in African countries. The overall prevalence ranged from 2.5 to 14.8% (up to twice as high as the average European prevalence of 7.1%). The pooled cumulative incidence and density of ICU-acquired HAIs were 34.7% (95% CI 23.6–47.7) and 47.9 per 1000 patient days (95% CI 36.7–59.1), respectively. The real burden of HAIs is likely to be even greater in settings with weaker infrastructures and fewer resources. Most of the data available are from surveys conducted in university teaching hospitals which function as referral hospitals. The data available from the continent does not provide a comprehensive picture of the overall burden of HAI; instead, it provides the best overview possible while highlighting the many existing gaps [73].

South and Southeast Asia

Data from Asia are mostly isolated and limited to one or few hospital data, not a representation of the health systems of the country. The International

Nosocomial Infection Control Consortium (INICC) network which has data of ICUs from the developing world also demonstrates value which is two- to threefold higher than ICUs in high-income countries. As a part of this network, there is a study of four hospitals in China [74] and seven hospitals (12 ICUs) from India. However, the study also claims that data may not accurately reflect the clinical setting of the country, and variations regarding surveillance methods may have affected the HAI rates [75]. A systematic review and meta-analysis of the burden of HAI in Southeast Asia revealed a pooled prevalence of overall HAI to 9% [76]. The data contributed by smaller Asian countries like Philippines, Pakistan, and Thailand only reiterate the fact that HAI rates are threefold higher than the USA and that too is an under-report [77]. Brazil, Cuba, Mexico, Thailand, and Egypt in recent times are examples of few countries in the developing world that have established a national surveillance program for HAI. In most of other LMICs, the path to reducing the burden of HAI is still a challenge [4].

Conclusion

The future of patient safety is a responsibility of the medical community across the globe. The burden of HAI and AMR can be significantly reduced in the developing world through support of international organizations (WHO), agencies (CDC, ECDC), and professional societies (e.g., SHEA, APIC, IFIC, APSIC, HIS) and commitment from governments. The knowledge, research findings, and technical know-hows that are available could help in adaptation of suitable guidelines and customized to the needs of the developing nations. The WHO initiatives such as World Alliance for Patient Safety have become a global campaign. Its creation has helped to coordinate, spread, and accelerate improvements in reducing HAI [78]. It is well recognized that the problem of HAI is multidisciplinary, multi-organizational, and multinational. An effort to reduce the burden therefore needs a multi-prong approach of industrialized and developing nations working together towards patient safety.

Compliance with Ethical Standards

Conflict of Interest
Sharmila Sengupta declares that she has no conflict of interest.
Purabi Barman declares that she has no conflict of interest.
Jamie Lo declares that she has no conflict of interest.

Human and Animal Rights and Informed Consent
This article does not contain any studies with human or animal subjects performed by any of the authors.

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