



The Real Scenario in Infection Prevention and Control in Low- and Middle-Income Countries: the Challenge of “Starting From Scratch”

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Abstract

Purpose of review Infection control and prevention (the routine use of infection prevention and control policies, procedures, and interventions in healthcare institutions) is fundamental to improving patient care outcome while ensuring the health and safety of healthcare workers, patients, and visitors.

Healthcare facilities with an effective infection prevention and control (IPC) program have demonstrated a decrease in healthcare-associated infections, a common complication of interaction with healthcare, through adherence to IPC guidelines resulting in safer clinical care environments and impacting patient morbidity and mortality.

Recent findings A safer clinical care environment and adherence to certain basic principles are fundamental for IPC programs, all leading to an impact on patient morbidity and mortality. However, recent experience in developed countries suggests possible lowering of hospital-acquired infection rates is achieved only when infection control is accepted as core to the healthcare institutions.

Summary The prevalence of hospital-acquired infection (HCAI) is well known in developed countries (Rosenthal et al. 2011). These infections incur additional costs, extend hospitalization, increase treatment costs, increase antimicrobial resistance, increase disabilities, and increase patient morbidity and mortality. It is generally accepted due to a lack of robust

surveillance systems that HCAs are higher in low- and middle-income countries and especially in LMIC intensive care units.

Healthcare-associated infection rates are generally higher in low- and middle-income countries compared with high-income countries resulting in a relatively larger incidence of patient mortality, disability, and additional healthcare cost.

An earlier observation, the SENIC Study (1985) published by Haley RW et al. showed that 6% of nosocomial infection can be prevented by minimal infection prevention and control efforts and 32% could be prevented by a very well-organized infection prevention and control program.

More recent published guidelines have demonstrated that it is possible to control the spread of multidrug-resistant Gram-negative and Gram-positive bacteria priority organisms in low- and middle-income countries using IPC interventions despite resource limitations (WHO 2017).

This narrative will attempt to define the important concept of “PROGRESS”—a roadmap to define the essential aspect of starting an infection prevention and control program “from scratch” with emphasis on resource-limited settings.

The acronym PROGRESS from scratch in a resource-limited setting in low- and middle-income countries attempts to define mechanisms and multimodal strategies for starting IPC programs to reduce the overall patient morbidity and mortality associated with HCAs in these settings.

Introduction

The impact of robust infection prevention and control programs can halt the spread of infections in healthcare settings. Multidrug-resistant Gram-negative rods (MDR-GNR) and some Gram-positive bacteria are emerging as a major challenge to human and animal health. This is especially true in low- and middle-income countries (LMIC) who have rudimentary or non-existent infection and prevention control programs [1••, 2].

In Africa and Asia, it is well known that MDR-GNR bacteremia is common in neonates and young infants [1••, 2]. As much as 1.4 million people worldwide suffer from healthcare-associated infections. In total, 5–10% of patients admitted to modern hospitals in the developed world acquire one or more infections [3]. In the USA, one out of every 136 hospital patients becomes seriously ill as a result of an infection acquired in a hospital; this is equivalent to two million cases and about 80,000 deaths a year. In the UK, more than 100,000 cases occur yearly, and these infections lead to about 5000 deaths directly each year. Hospital-acquired infections in the UK and USA are estimated to cost £1 billion a year and US\$ 5.7 billion per year respectively. In Mexico, an estimated 450,000 cases of health care-associated infections cause 32 deaths per 100,000

inhabitants each year with the annual cost approaching US\$ 1.5 billion [3]. For low- to middle-income countries and smaller economies, the cost can potentially be astronomical with the risk of these infections in developing countries being 2 to 20 times higher than that in developed countries [3]. This can culminate in morbidity and mortality increases in these settings. There is limited data on the impact of healthcare-associated infections in resource-constrained settings.

Following the unprecedented approval of the Global Action Plan for Antimicrobial Resistance at the 68th World Health Assembly in May 2015 and the subsequent high-level meeting of the UN General Assembly on Antimicrobial Resistance held in September 2016, member states agreed on the importance of moving forward to develop National Action Plans by May 2017. Part of this plan involves developing and restructuring infection prevention and control (IPC) programs. This drive has brought attention to many middle- to low-income countries with limited/constrained resources. The overall risk of healthcare-associated infections in the developing countries can exceed by 25% that of developed countries leading to an increase in mortality and morbidity with an increase

in financial resources which are already constrained [4••, 5••, 6].

The concept of knowing the aspects required for “PROGRESS” can be used in resource-limited settings in starting programs “from scratch” while utilizing the “IDEAL” concept previously mentioned.

Fighting antimicrobial resistance (AMR) requires a robust infection prevention and control program. Understanding the aspects required for PROGRESS used in conjunction with the IDEAL framework can

be utilized in the start-up of IPC programs from scratch, in resource-limited settings. Supporting the education aspect of PROGRESS, a recent study in 2017 by Forde et al. shows a clear example of how outbreak scenarios can be used to drive change at the national level and regional level and can serve as a model for development of rudimentary infection prevention and control programs in resource-limited settings [7•].

Approach

Starting an infection control program from “scratch”

The World Health Organization has recently updated its core components of an infection prevention program [8••]. These include:

- *Core component 1:* Infection prevention and control programs
- *Core component 2:* National- and facility-level infection prevention and control guidelines
- *Core component 3:* Infection prevention and control education and training
- *Core component 4:* Healthcare-associated infection surveillance
- *Core component 5:* Multimodal strategies for implementing infection prevention and control activities
- *Core component 6:* Monitoring and evaluation and feedback
- *Core component 7:* Workload, staffing, and bed occupancy at the facility level
- *Core component 8:* Built environment, materials, and equipment for infection prevention and control at the facility level

IPC program successes in resource-limited settings including Latin America, the Caribbean, Asia, and the African continent have been linked to outbreak scenarios. These scenarios can help drive change not only at the facility level but also at the national level and in the case of the Caribbean the regional level [7•].

A multimodal strategy approach is essential when starting an IPC program in resource-limited settings. This will be effective on reducing the spread of carbapenem-resistant *Acinetobacter baumannii* (CRAB), carbapenem-resistant *Pseudomonas aeruginosa* (CRPSA), and carbapenem-resistant Enterobacteriaceae (CREs) which have been recognized as priority organisms by the WHO (WHO 2017). This approach includes surveillance, hand hygiene, contact and isolation precaution implementation, patient cohorting, and enhanced environmental cleaning.

The PROGRESS model can be used to identify key challenges and to ask key questions in starting an IPC program from scratch (see Fig. 1 and Table 1).

There are several barriers to starting an IPC program from scratch. These include but are not limited to:



Fig. 1. The acronym PROGRESS.

1. Lack of scientific data including surveillance data on HCAI prevalence rates within the resource-limited settings
2. Perceived financial burden with no clear benefits
3. An unclear knowledge of benefits from changing from the norm
4. Lack of IPC leadership at the institution and country levels.

The programs in resource-limited settings can be used to provide a practical approach to IPC program intervention using the framework provided by the WHO [8••].

The framework provided by the WHO [8••] provides a practical approach using IPC program interventions which can be adopted in resource-limited settings.

The key components of the PROGRESS model using recent literature examples in low- and middle-income setting will now be examined.

Table 1. This indicates the key question to ask in starting a program from scratch in middle- to low-income countries

PROGRESS model components	Key questions to be asked in designing IPC from scratch in low- and middle-income countries
Political will	Is it present? How can it be achieved? Who do you engage?
Resource distribution and utilization	Do you have the physical and human resources in a country to make the start? How are current resources being utilized?
Observation	What data do you have available? What are the success stories from literature that can be used in your setting?
Goal setting	What are the immediate short-term and long-term goals? What are key annual goals for the program?
Reassessment	When will the assessment period be? By what measures will success be evaluated? (Gap Assessment Tools)
Education	Who should be the target audience? How is this intervention expected to change behavior? How to define the frequency of the core components of the training program? How to establish continuous training programs locally or internationally for IPC key personnel?
Surveillance strategy	What are the key surveillance areas for your setting? Where and when will surveillance be done and for how long? Who will these results be reported to and what is the feedback mechanism?
Stewardship program development	What are the “low-hanging fruits,” i.e., easily obtainable targets? What are the minimal resources required? What is my current laboratory capacity?

Political will

Political will is widely recognized as important, yet its impact is profoundly underestimated in the resource-limited setting. Political will for the purpose of this article requires that a sufficient set of decision makers (institution level and national level) intends to support a particular initiative and that such support is committed through resource distribution. Political will always represents the most important features of a successful IPC program [9••, 10]. Literature example by Forde C, Steersman B, et al. (2017) discussed how an outbreak can drive change at the institutional, national, and regional levels. Political will can be driven through impressing to political leaders that major outbreaks can devastate the tourism sectors in countries where tourism represents a large percentage of the GDP [7•, 9]. The recent Ebola outbreak in Africa represents one of the most memorable IPC examples of the impact of weak IPC programs on a country's tourism, GDP, and overall economic growth [11••]. To get "buy in," outbreak scenarios and local data presentation have been used to drive political will and bring about change at the institution and national levels [7•, 12]. The ultimate aim would be to have a national-based focal point for infection prevention and control with a National Infection Prevention and Control Committee.

When meeting to discuss, either improvement or "starting from scratch" would include:

- An agenda framed around the problem (i.e., lack of infection control) using detailed facts which are institutional
- Amicable solutions; it is always important to not only present problems alone, but present solutions based on perceived roadblocks
- Use local scientific information, e.g., outbreak scenarios, local/regional success stories following IPC program implementation
- Focused discussion on burden of outbreak including additional cost necessary to bring outbreak to a close
- Importance of communication—internal and external consumers—engage the public and the media (newspaper, TV, and social media) for sustainability
- Demonstrate where possible the benefits of adhering to a no- or low-cost implementation strategy

Resource distribution and utilization

For low- and middle-income countries, this provides one of the biggest challenges. These include but are not limited to:

- Limited access to qualified and trained professionals
- Limited human and material resources
- Inadequate or no budgets allocated to IPC

When starting a program from scratch with low resources for implementation, multiple cost-effective strategies are used. These may include, but are not limited to:

1. Education and practical training for staff in areas of hand hygiene, aseptic techniques, and appropriate personal protective equipment (PPE) use
2. Provision of alcohol-based hand rub and handwashing facilities on units

3. Use of appropriate decontamination processes for reusable medical devices and equipment used for invasive procedures
4. Provision of hepatitis B vaccination for all healthcare workers along with post-exposure prophylaxis for illnesses such as HIV.

A majority of the responsible parties in middle- to low-income countries express the difficulties in the formation of IPC and antimicrobial stewardship programs due to resource limitations (Table 2). The WHO recently published a newsletter on antimicrobial resistance and the impact of resource utilization. It demonstrated that sometimes resources are available but are inappropriately utilized; for example, laboratory resources: routine environmental weekly swabbing and culture of all indwelling catheters upon removal [13••]. Therefore, it is important to review what is done routinely, and discontinue what is not a necessity in building an IPC program. These practices can inflate laboratory costs without significant clinical impact and drive inappropriate usage of antibiotics.

It is also important to select persons who are knowledgeable or have an interest in antimicrobial stewardship to be members of the institutional IPC team. The Chairman of the IPC Committee when “starting from scratch” should be someone who has practical knowledge of AMR, stewardship, and IPC or who can be trained in IPC.

Observation

Observation or a review of infection prevention and control programs through literature searches for success stories is a valuable strategy when starting from scratch. There is often no need to “reinvent the wheel.”

New IPC programs should use lessons learnt from similar settings. These success stories and challenges encountered can be used in the next aspect of goal setting.

Goal setting

Personnel always perform better when they are committed to achieving goals. Goal setting involves the development of an action plan designed to motivate and guide personnel or the IPC group toward a target. Starting from scratch should mean that institutions should set targets in alignment with national goals. Benchmarking of “low-hanging fruits” that are easily attainable goals is

Table 2. The IDEAL framework by Nalini et al. can be used as a framework to develop robust antimicrobial stewardship/resistance programs in low- and middle-income countries [5••]

This IDEAL framework includes	
I	Implement programs for infection prevention and control
D	Develop antimicrobial and diagnostic stewardship based on local data
E	Enhance interventions based on relevant technical and behavioral factors to improve impact
A	Accreditation of healthcare institutions to improve quality and safety of care
L	Legislation to ensure compliance with accreditation

crucial. Success in the West African Ebola Outbreak of 2015 came through benchmarking in the low-resource settings of key aspects for success including handwashing campaigns and the use of personal protective equipment [11••].

Short-, medium-, and long-term written plans (goals, objectives, and outcomes with timelines) in alignment with the country's National Action Plan to combat antimicrobial resistance should be well outlined. All healthcare facility IPC programs should be written with annual targets.

Reassessment

Reassessment involves re-evaluating the program, or reappraising it, as the healthcare environment has changed, or new information becomes available.

Reassessment of the IPC program should be standardized at least for goal assessment in the low- and middle-income setting. This is best done by the in-house IPC team, but it is crucial to have an external assessment and validation by an accreditation organization of the IPC program. There are several standardized tools which can be used for reassessment. These include but are not limited to CDC IPC assessment tools, and PAHO and WHO assessment tools for the program.

A few examples are seen in Fig. 2.

External assessments come through entities such as WHO, PAHO, CDC, and Accreditation Canada Assessment tools once the appropriate request is made for assistance.

Education

The educational component of an IPC program is key to its success. This is particularly true in resource-limited settings. In 2017, Lute Ara et al. published an article highlighting the differences in the effect of a multimodal infection control intervention among the healthcare workers: a comparison between public and private hospitals in Bangladesh [14]. Lute Ara et al. study aimed to compare the effects of a multimodal IPC intervention to improve knowledge and skills of healthcare workers at public and private hospitals in Bangladesh to establish that healthcare workers of Bangladesh lacked adequate knowledge about standard IPC procedures which posed serious threats on patient health and their occupational safety. This study further highlights the importance of education and engagement of staff (paraclinical, clinical, and administrative staff), general public, and visitors to the institution in middle- to low-income countries. As part of a multimodal strategy, one may consider starting with an

Reassessment

Internal Audits of program & External Audits are Necessary Audit tools for monitoring infection control standards and the Nosocomial Infection Program Rapid Evaluation Guide, produced for use in LMI countries by the Pan American Health Organization/Regional Office of the WHO (PAHO)

CDC AUDIT TOOL,
[Infection Control Assessment Tool for Acute Care Hospitals](#)
[Infection Control Assessment Tool for Long-term Care Facilities](#)
[Infection Control Assessment Tool for Outpatient Settings](#)

IPC CANADA
https://ipaccanada.org/photos/custom/Members/Tools/PAT_Workbook.pdf

Fig. 2. Several standardized tools which can be used for reassessment.

institutional-, community-, and country-based campaign on hand hygiene [15••]. This may encompass use of poster slogans and flyer competitions (in schools). This will fit well in targeting the population and refocusing the IPC program if already present.

A continuously refined staged and targeted education program needs to occur in alignment with the national and institution goals. The use of social media and information technology when available may be useful (e.g., LinkedIn, Instagram, WhatsApp, and Facebook). Screen savers with key IPC messages on desktops on units at healthcare facilities may form helpful reminders to healthcare workers to wash hands and wear appropriate personal protective equipment and give valid reminders on how to prevent needlestick injuries. All IPC programs should have an IPC manual for distribution across the facility identifying the key IPC aspects as defined by WHO key components [8••].

Education of IPC personnel

This should be a continuous process and will involve training of the IPC team and key members in departments in hospitals as champions of infection prevention and control. It should involve three levels of engagement—local, regional, and international.

Local level

Engage other local healthcare facilities in training through continuous educational workshops, symposiums, and research projects. The development and execution of an infection control champion program would also be additional IPC education for targeted healthcare workers.

Regional level

A formal regional IPC association may help small island states with limited human and professional resources to pool these resources collectively having more clout in comparison to individual island states.

A recent example of this was seen in the Caribbean region where personnel meet annually as part of the International IPC Week to address and share IPC experiences [6, 7•].

International level

IPC personnel need to actively engage international institutions and organizations for assistance in IPC opportunities. This will need political support in most countries. These may include CDC, WHO/PAHO, and international universities, among others. Mentorship program exchanges in the early stages with international hospitals are paramount. IPC personnel are encouraged to join large, established IPC international bodies to facilitate continuous education: APIC, SHEA, ECMID, IPS, and IDSA, among others.

Surveillance strategy

Starting a surveillance program “from scratch” in resource-limited settings can be quite challenging, as it can be hampered by human and physical resources.

Building a surveillance program should involve an initial assessment of the present laboratory capacity and engage the laboratory technicians before embarking on the PROGRESS program.

Standardized national or regional surveillance definitions are required for healthcare-associated infections which are applicable at the local and regional levels. In low- to middle-income settings, the standard international definitions (CDC, NHS) cannot be applied due to less than robust laboratory capacity or insufficient resources in these regions for sustainability of international definitions. However, it is possible to carry out surveillance of healthcare-associated infections even in the absence of microbiological confirmation. A physician or surgeon diagnosis of infection derived from direct observation or from clinical judgment is an acceptable but crude criterion for healthcare-associated infections in settings where microbiological data cannot be achieved [16].

It is important to conduct targeted surveillance, and this should be institutionally based. The selection of one or two key surveillance areas based on institutional risk with a clear established feedback reporting system for identified cases is key [17]. Feedback of surveillance data to administrators and front-line healthcare staff is important. The aim of this program would ultimately be to help drive change for success in something as simple as hand hygiene auditing.

Stewardship program development

The Society of Healthcare Epidemiology of America (SHEA) has defined antibiotic stewardship as a set of coordinated strategies to improve the use of antimicrobial medications with the goal of enhancing patient health outcomes, reducing resistance to antibiotics, and decreasing unnecessary costs. No effective IPC program can survive without an antimicrobial stewardship program.

This is often hampered by:

1. Limited access to qualified and trained professionals
2. Limited human resources
3. Inadequate budgets
4. Implementation challenges eg. Lack of rapid diagnostic testing
5. Need for adaptation or tailoring to the local context
6. Quality microbiological/laboratory, IT, and data management systems are requirements for surveillance and auditing; in their absence, surveillance based on clinical data could be considered.

The key in low- and middle-income countries includes starting small while building up capacity over time. Important aspects to consider include:

1. Use clinicians from one or two departments to lead the cause (critical care and pediatricians are likely to be more amenable)
2. Antibiotic champions
3. Monitor the use of one/two classes of very "high-end" antibiotics (colistin/polymixin B and carbapenems)
4. Justification forms for empiric use may be helpful
5. Create peer pressure by portraying those clinicians who use antibiotics judiciously—positive reinforcement

The use of audit programs in antibiotic use and the use of champions within the institution to support the program are essential for success of any new program.

Conclusions

There are now many examples internationally in Asia, Africa, and the Caribbean and Latin America of success stories in infection prevention and control in resource-limited/resource-constrained setting in low- and middle-income countries.

The common challenges to be encountered in a resource-limited setting include:

1. Limited access to qualified and trained professionals
2. Limited human resources
3. Inadequate budgets
4. Implementation challenges
5. Need for adaptation or tailoring to the local context
6. Quality microbiological/laboratory, information technology, and data management systems are requirements for surveillance and auditing; in their absence, surveillance based on clinical data could be considered

The PROGRESS roadmap identified above can be used as an effective strategy in the implementation of infection prevention and control programs from "scratch" in low- and middle-income countries.

Compliance with Ethical Standards

Conflict of Interest

Corey A. Forde declares that he has no conflict of interest.

Yvonne Martindale declares that she has no conflict of interest.

Suleman Patel declares that he 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. With regard to the authors' research cited in this paper, all procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. In addition, all applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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- Of major importance

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