INVESTING IN INFECTION PREVENTION AND CONTROL TO CONTAIN ANTIBIOTIC RESISTANCE: PROGRESS IS ACHIEVABLE

DR BENJAMIN J PARK (TOP LEFT), CHIEF, INTERNATIONAL INFECTION CONTROL PROGRAM, OFFICE OF THE DIRECTOR, DIVISION OF HEALTHCARE QUALITY PROMOTION, CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC), USA; **DR DENISE CARDO** (TOP RIGHT), DIRECTOR, DIVISION OF HEALTHCARE QUALITY PROMOTION (DHQP), NATIONAL CENTER FOR EMERGING AND ZOONOTIC INFECTIOUS DISEASES, (CDC), USA AND **DR MICHAEL BELL** (BOTTOM LEFT), DEPUTY DIRECTOR, DIVISION OF HEALTHCARE QUALITY PROMOTION, NATIONAL CENTER FOR EMERGING AND ZOONOTIC INFECTIOUS DISEASES (CDC), USA



In many low- and middle-income countries, infection prevention and control (IPC) is an often overlooked, but critical, capacity for safe clinical care, including the reduction and containment of antimicrobial resistant (AR) pathogens. Around the world, there remain fundamental gaps in IPC capacity and implementation, with many efforts limited to temporary stop-gap measures, e.g., during emergencies. However, it is critical to identify and implement sustainable solutions to address those gaps in all healthcare settings. Progress can be achieved and should be prioritized. All countries have a stake in fixing this problem.

In past decades, healthcare settings have been recognized as amplifiers of transmission of emerging infections such as SARS and Ebola. Today, antibiotic resistance (AR) is a globally acknowledged threat to healthcare and public safety that is likewise amplified in healthcare. In these settings, the combination of high antimicrobial medication exposure, prevalent invasive procedures and devices, and close contact required for patient care create an environment where AR pathogen transmission can be rapidly amplified. Many healthcare-associated AR threat pathogens have been listed by national and international groups, including US CDC and WHO *(1, 2)*, and many nations and regions have chosen to aggressively target those pathogens for tracking and control *(3, 4)*. Infection prevention and control (IPC) is critical to combat these pathogens and can only be accomplished where robust investments in healthcare personnel, training, supplies and hygienic infrastructure are sustained.

IPC is crucial to delivering and maintaining effective medical care, with direct impacts on the safety of patients and healthcare personnel. It is an ongoing set of activities that take place in the background of clinical settings and is usually only noticed during a crisis (e.g., Ebola epidemic) or when an IPC lapse has occurred leading to patient or healthcare personnel harm (e.g., transmission of hepatitis virus due to incorrect injection practices). IPC activities include ensuring sufficient and sustained hygienic infrastructure (clean water for healthcare facilities, effective sewerage removal, clean and safe removal and containment of medical waste, access to electricity) that is at least sufficient for the nature of care being provided; staffing and material support to implement environmental cleaning and disinfection; adequate supplies of single-use equipment; correct reprocessing of reusable equipment; monitoring and record-keeping for healthcare-associated infection (HAI) surveillance; oversight to ensure consistent adherence to correct injection practices; appropriate use of triage, isolation precautions and personal protective equipment; and staff training to correct any unsafe practices identified in the clinical care setting.

Achieving the broad mission of IPC requires national policies that support human and hygienic infrastructure and resources that are reliably sustained and tailored to intended healthcare delivery needs. Interventions to slow the advance of AR must be safe for patients, appropriate for local conditions and consistently implemented by facilities, clinicians and governments. Short-term options include strong and consistent public and clinician information campaigns to highlight the

negative consequences of antibiotic misuse and change the underlying demand for unnecessary antibiotics. Appropriate attention to individual and environmental hygiene, and standard infection control practices, should be applied by personnel in all facilities to prevent cross-transmission and amplification of pathogens, including resistant organisms, in healthcare settings. In addition, facilities can assess the quality of their microbiology laboratory resources and personnel to identify gaps and areas of need; even limited diagnostic microbiology capacity could be applied to perform periodic prevalence surveys to produce antibiograms to guide clinical staff.

The global challenge of AR continues to grow, particularly in countries with developing economies where healthcare utilization is expanding rapidly. Antibiotics are now widely delivered and basic care, including childbirth in hospitals, is increasingly available thanks to concerted efforts of donors, NGOs, public health and governments. Advanced care, e.g., for cancer and many chronic illnesses, has become more accessible, too; yet, IPC capacities that are critical for patient safety have not grown to adequately support those growing clinical capabilities. As a result, the problem of AR in LMICs is substantial and will likely grow as healthcare expands. Reports from Asia have described the increasing prevalence of Enterobacteriaceae resistant to carbapenems *(5, 6)*. A 2014 WHO report describe AR prevalences as high as 20% in some countries *(7)*, and in Latin America, PAHO's ReLAVRA system reports a 20%–30% prevalence of carbapenem resistance among Klebsiella in some countries *(8)*. Reports of outbreaks of healthcare-associated infections caused by pathogens with emerging resistant genotypes are documented in many countries, along with global spread attributed to travel and migration *(9-11)*.

All countries are stakeholders in containment and therefore need to be part of the solution. High-income countries with robust approaches to antimicrobial stewardship and IPC can still suffer rapid loss of treatment capability for common infections when AR pathogens are imported from abroad. Recent travel is a recognized risk factor for colonization of concerning AR pathogens *(12, 13)*. Receipt of healthcare in other countries has been associated with colonization with locally acquired AR strains and has required public health measures to rapidly identify and isolate colonized patients before spread in the facility occurs *(14)*. The growing practice of medical tourism has also been described as leading to the spread of AR pathogens *(15)*. In addition to risking harm to their own populations, high-income countries also risk economic hazards related to international epidemics (e.g., the 2014 MERS outbreak in the Republic of Korea stemming primarily from IPC gaps that allowed transmission within the healthcare facilities. As community fear led to self-isolation, economic output dropped by 2% and led to intervention by the Central Bank *(16)*); and globally, health investments by donor organizations are threatened by the rapid advance of AMR and its undermining of basic medical care delivery. Finally, despite urgent efforts to identify new antibiotics, pharmaceutical investments will be rapidly washed away if current patterns of healthcare delivery without IPC and optimal use of existing antibiotics are maintained.

Although initial investments in sustainable IPC and hygienic infrastructure for healthcare might seem high, they can and should be tailored to match the specific types of care intended to be provided at each healthcare facility. Implemented thoughtfully, those investments will have the potential for large and lasting impacts. Examples of successful implementation include Vietnam, where a national programme to strengthen IPC to target AR pathogens is now being implemented in phases, starting in selected healthcare facilities and expanding throughout the country over several years. In Kenya, the national AR action plan calls for a phased implementation of surveillance and prevention programmes for AR pathogens, starting at two sites with a plan for gradual expansion. In Sierra Leone, after the Ebola outbreak highlighted the critical role of IPC in public health outbreaks, the Ministry of Health has created a new national office to direct facility level quality improvement programmes.

The success of these programmes hinges on sustained implementation supported by national policies that include a long-term commitment to maintaining IPC wherever patient care is delivered. Policies should specify and prioritize resource allocation to ensure that human resources, training, medical and cleaning supplies, clinical laboratory capacity, water, sewerage, waste management and electricity allow each healthcare facility to operate in accordance with recognized IPC standards to protect patients and healthcare staff. National IPC focal points should be designating and/or strengthening within governments to oversee implementation of IPC capabilities and track progress. The latter requires a meaningful way to measure both AMR outcomes such as HAI incidence or prevalence, antimicrobial use, and processes related to IPC (e.g., adherence to safe injection practices, availability of necessary supplies). By using data for action, governments can determine where to focus national efforts and plan for each successive step in implementing appropriate IPC, addressing AR pathogens and improving the safety for all patients receiving care.

Many LMIC settings work with external support from donors. It is imperative that donor organizations make commitments that are not only responsive to urgent, short-term needs, but also include sustainable, locally suited development of capacity that can sustain improved practices for many years. This should

be a routine consideration for all response activities, which despite being well-intentioned, can have lasting unintended impacts long after the acute crisis has passed.

AR is a threat that encompasses the entire planet without regard to geographic or political borders. It is time for a shared vision and concerted approach that addresses long-term needs of LMIC and high-income nations and moves away from stop-gap or uncoordinated actions that reduce the net impact of precious investments. There is no quick fix for AR, but with consistent, sustained investments in public health measures, in particular IPC and hygienic infrastructure in healthcare settings, we can and must achieve progress. ■

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Dr Benjamin J Park, MD, is the chief of the International Infection Control Program in the Division of Healthcare Quality Promotion, US Centers for Disease Control and Prevention, in Atlanta, Georgia. He is leading the CDC international infection control efforts globally and is the CDC co-lead for antimicrobial resistance (AMR) in the Global Health Security Agenda (GHSA) program. Under his lead, CDC's International Infection Control Program has helped to respond to outbreaks and improve infection control in healthcare systems in over 15 countries since 2014.

Dr Denise Cardo is the director of the Division of Healthcare Quality Promotion (DHQP), National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention (CDC). Dr Cardo joined CDC in 1993 as a medical epidemiologist in the Hospital Infections Program (later named as DHQP). After holding several leadership positions in DHQP, she was selected as division director in 2003. From November 2012 to September 2013, Dr Cardo was the Acting CDC Deputy Director for Surveillance, Epidemiology and Laboratory Services.

Prior to joining CDC, she had a distinguished career in the division of infectious diseases at one of Brazil's prestigious medical institutions, Escola Paulista de Medicina, Sao Paulo, Brazil, where she received her medical degree, completed her residency and fellowship, and joined the faculty as associate professor of infectious diseases. During 1990–1991, she did a sabbatical at the Hospital Epidemiology Program, University of Tennessee, Memphis.

Dr Cardo has been involved in healthcare epidemiology and hospital infections since 1984 and is internationally recognized as an expert and leader in the area.

Dr Michael Bell is the Deputy Director of CDC's Division of Healthcare Quality Promotion. Prior to that he served as the Associate Director for Infection Control and was the Executive Secretary for the US Healthcare Infection Control Practices Advisory Committee. His career has focused on investigating and preventing transmission of healthcare-associated illness, and development of evidence-based infection control guidelines. Prior to his current position at CDC, he was the Chief of the Epidemiology Unit at the Viral Special Pathogens Branch, addressing control of high-risk pathogens. He received his medical degree from the University of Washington and trained in Infectious Diseases at the University of California San Francisco.

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