
Implementation manual to prevent and control the spread of carbapenem-resistant organisms at the national and health care facility level

Interim practical manual supporting implementation of the Guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* in health care facilities



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OVERALL COORDINATION AND WRITING OF THE DOCUMENT

Benedetta Allegranzi and Julie Storr (Department of Service Delivery and Safety, WHO) coordinated the development of this document. Julie Storr and Benedetta Allegranzi wrote the document. Jolanta Griskeviciene (Department of Service Delivery and Safety, WHO) made an inventory of available documents and country examples related to the implementation of prevention and control measures for carbapenem-resistant organisms. Rosemary Sudan provided professional editing assistance.

EXPERT CONTENT DEVELOPMENT AND REVIEW WORKING GROUP

The key concepts included in this manual were first discussed in a technical consultation in May 2018 with the contribution of the following experts:

Anucha Apisarnthanarak (Thammasat University Hospital, Thailand); Batyrbek Aslanov (North Western State Medical University, Russia); Sanjay Bhattacharya (Tata Medical Center - Kolkata, India); An Caluwaerts (Médecins Sans Frontières/Doctors Without Borders, Belgium); Roderick Chen Camano (Caja Seguro Social Hospital, Panama); Ana Paula Coutinho

Rehse (WHO Regional Office for Europe); George L. Daikos ("Laikon" and "Attikon" Hospitals, Greece); Nizam Damani (Department of Service Delivery and Safety, WHO); Nino Dayanghirang (WHO Regional Office for Africa); Devika Dixit (Infectious Hazard Management, WHO); Sergey Eremin (AMR Secretariat, WHO); Corey Forde (Queen Elizabeth Hospital, Barbados); Laetitia Gahimbare (WHO Regional Office for Africa); M. Lindsay Grayson (Austin Health, Australia); Neil Gupta (Centers for Disease Control and Prevention [CDC], United States of America [USA]); Stephan Harbarth (Geneva University Hospitals, Switzerland); Iman Heweidy (Ain Shams University, Egypt); Joost Hopman (Radboud University Hospital & Médecin Sans Frontières/Doctors Without Borders, The Netherlands); Shahdan Bijie Hu (Chinese Infection Control Association, China); Kushlani Jayatilleke (Sri Jayewardenapura General Hospital, Sri Lanka); Marimuthu Kalisvar (Tan Tock Seng Hospital, Singapore); Claire Kilpatrick (Department of Service Delivery and Safety, WHO); Iwamoto Kotodji (Health Technologies and Pharmaceuticals, WHO); Maria Luisa Moro (Agenzia Sanitaria e Sociale Regionale, Italy); Huynh Tuan Minh (University Medical Center, Viet Nam); Saskia Andrea Nahrgang (WHO Regional Office for Europe); Babacar Ndoye (WHO Regional Office for Africa); Folasade Ogunsola (University of Lagos, Nigeria); Josephine Okine (Winneba Municipal Hospital, Ghana); Mauro Orsini (Ministry of Health, Chile); Iyer Ranganathan (Global Hospital, India); Annicka Reuss (Robert Koch Institute, Germany); Hatim Sati (Pan American Health Organization [PAHO]); Mitchell J Schwaber (National Center for Infection

Control, Israel); Karen Shaw (Public Health England, United Kingdom); Nalini Singh (George Washington University Schools of Medicine & Health Sciences and Public Health and Children's National, USA); Rachel M. Smith (CDC, USA); Astrid Wester (WHO Environment and Social Determinants); Marie Louise Wright (WHO Regional Office for Europe); Danilo Lo Fo Wong (WHO Regional Office for Europe); Bassem Zayed (WHO Regional Office for the Eastern Mediterranean); Peta Anne Zimmerman (Griffith University, Australia).

The manual content was further developed with the substantial contribution and/or review by the following experts:

Anucha Apisarnthanarak (Thammasat University Hospital, Thailand); Richard Aschbacher (Bolzano Central Hospital, Italy); Batyrbek Aslanov (North Western State Medical University, Russia); Sanjay Bhattacharya (Tata Medical Center - Kolkata, India); An Caluwaerts (Médecins Sans Frontières/Doctors Without Borders, Belgium); Roderick Chen Camano (Caja Seguro Social Hospital, Panama); Alessandro Cassini (Department of Service Delivery and Safety, WHO); George L. Daikos ("Laikon" and "Attikon" Hospitals, Greece); Nizam Damani (Department of Service Delivery and Safety, WHO); Becaye Fall (Hôpital Principal de Dakar, Senegal); Corey Forde (Queen Elizabeth Hospital, Barbados); Wendy Graham (SOAPBOX Collaborative); M. Lindsay Grayson (Austin Health, Australia); Stephan Harbarth (Geneva University Hospitals, Switzerland); Iman Heweidy (Ain Shams University, Egypt); Joost Hopman (Radboud University Hospital & Médecin Sans Frontières/Doctors Without Borders, The Netherlands);

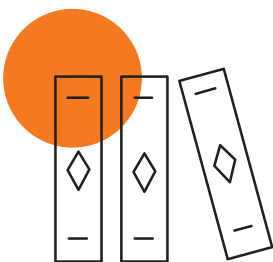
Marimuthu Kalisvar (Tan Tock Seng Hospital, Singapore); Shaheen Mehtar (Infection Control Network Africa, South Africa); Maria Luisa Moro (Agenzia Sanitaria e Sociale Regionale, Italy); Babacar Ndoeye (WHO Regional Office for Africa); Josephine Okine (Winneba Municipal Hospital, Ghana); Iyer Ranganathan (Global Hospital, India); Benjamin Park (CDC, USA); Molly Patrick (CDC, USA); Hatim Sati (PAHO); Mitchell J Schwaber (National Center for Infection Control, Israel); Karen Shaw (Public Health England, United Kingdom); Rachel M. Smith (CDC, USA); Valeska Stempliuk (PAHO); João Toledo (WHO Regional Office for the Americas).

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ABBREVIATIONS AND ACRONYMS

AMR	antimicrobial resistance
CDC	Centers for Disease Control and Prevention (Atlanta, USA)
CLED	cysteine-, lactose-, and electrolyte-deficient (medium)
CLSI	Clinical and Laboratory Standards Institute
CP	carbapenemase-producing
CPE	carbapenemase-producing Enterobacteriaceae
CRAB	carbapenem-resistant <i>Acinetobacter baumannii</i>
CRE	carbapenem-resistant Enterobacteriaceae
CRs	carbapenem-resistant organisms
CRPsA	carbapenem-resistant <i>Pseudomonas aeruginosa</i>
ECDC	European Centre for Disease Prevention and Control
EUCAST	European Committee on Antimicrobial Susceptibility Testing
GLASS	Global Antimicrobial Resistance Surveillance System
HAI	health care-associated infection
HHSAF	Hand Hygiene Self-Assessment Framework
IHR	International Health Regulations
IPC	infection prevention and control
IPCAF	Infection Prevention and Control Assessment Framework
KPC	<i>Klebsiella pneumoniae</i> carbapenemase
LMICs	low- and middle-income countries
MICs	minimum inhibitory concentrations
NDM	New Delhi metallo-beta-lactamases
OXA	oxacillinases
PCR	polymerase chain reaction
PPE	personal protective equipment
SDG	Sustainable Development Goals
SOP	standard operating protocols
USA	United States of America
VIM	Verona integrin-encoded metallo-beta-lactamase
WASH	water, sanitation and hygiene
WHO	World Health Organization



GLOSSARY OF KEY TERMS & DEFINITIONS

Alcohol-based handrub refers to an alcohol-based preparation designed for application to the hands to inactivate microorganisms and/or temporarily suppress their growth. Such preparations may contain one or more types of alcohol, other active ingredients with excipients, and humectants.

Basic sanitation facilities ensure the hygienic separation of human excreta and human contact and include flush/pour flush to sewers, septic tanks or pit latrines, ventilated pit latrines, pit latrines with slab or composting toilets. They are also usable and provide for the needs of all users (that is, staff and patients, women and people with limited mobility). To be considered usable, a facility should have a door that is unlocked when not in use (or for which a key is available at any time) and can be locked from the inside during use. There should be no major holes in the structure, the hole or pit should not be blocked, water should be available for flush/pour flush toilets, and there should be no cracks or leaks in the toilet structure. In addition, there should be at least one separate toilet for use by women/girls only, and a bin with a lid and/or water and soap available in a private space for washing.

Basic water supply is a supply that comes from an improved source (for example, a safely managed piped water, standpipe, tubewell/borehole, protected dug well or protected spring or rainwater) located at the health care facility and regularly provides water.

Biofilm refers to a community of microorganisms growing as a slimy layer on surfaces immersed in [or covered in] a liquid.

Bioburden is the number and types of viable microorganisms that contaminate the equipment/device.

Cleaning refers to the important first step of physically removing contamination by foreign materials from a surface or equipment, for example, dust, soil and organic material.

Cleaning agent refers to any product used to clean surfaces or equipment.

Detergent refers to a cleaning agent that increases the ability of water to penetrate organic material and break down grease and dirt. Detergents are needed to allow effective cleaning to take place.

Diagnostic stewardship consists of coordinated guidance and interventions to improve the appropriate use of microbiological diagnostics to guide therapeutic decisions. It should promote appropriate, timely diagnostic testing, including specimen collection, and pathogen identification to allow the accurate, timely reporting of results to guide patient treatment.

Dirty utility refers to the area in a ward where bodily fluids are disposed of. Other terms may be more familiar in different contexts, including 'sluice area'.

Disinfectant refers to a chemical agent that is capable of killing most pathogenic microorganisms under defined conditions, but not necessarily bacterial spores. It is a substance that is recommended for application to inanimate surfaces to kill a range of microorganisms.

Disinfection refers to a process that reduces the number of viable

microorganisms to a less harmful level. This process may not inactivate bacterial spores, prions and some viruses.

Hand hygiene refers to a general term related to any action of hand cleansing.

Hand hygiene station is a dedicated location with the necessary resources to enable hand hygiene to take place.

Health care-associated infection, also referred to as "nosocomial" or "hospital" infection, is an infection occurring in a patient during the process of care in a hospital or other health care facility, which was not present or incubating at the time of admission. Health care-associated infections can also appear after discharge. They represent the most frequent adverse event during care.

Health care facilities include all facilities caring for patients.

Health care worker refers to doctors, nurses and technical staff.

High-, low- and middle-income countries: WHO Member States are grouped into four income groups (low, lower-middle, upper middle and high) based on the World Bank list of analytical income classification of economies for the fiscal year, calculated using the World Bank Atlas method. For the current 2019 fiscal year, low-income economies are defined as those with a gross national income (GNI) per capita of US\$ 995 or less in 2017; lower middle-income economies as those with a GNI per capita between US\$ 996 and US\$ 3895; upper-middle-income economies as those with a GNI per capita of between US\$ 3896 and US\$ 12 005; and high-income economies as those with a GNI per capita of US\$ 12 056 or more.

Hospital cleaning staff refers to any member of the health workforce whose primary responsibility is to ensure a safe

hygienic environment through cleaning. In some countries, the following terms may be used: housekeeping staff; environmental services staff; hygiene and cleaning team; domestic staff; cleaning staff; cleaners; and hygienists.

Multimodal strategy: A multimodal strategy comprises several components or elements (three or more, usually five) implemented in an integrated way with the aim of improving an outcome and changing behaviour. It includes tools, such as bundles and checklists, developed by multidisciplinary teams that take into account local conditions. The five most common elements include: (i) system change (availability of the appropriate infrastructure and supplies to enable infection prevention and control good practices); (ii) education and training of health care workers and key players (for example, managers); (iii) monitoring infrastructures, practices, processes, outcomes and providing data feedback; (iv) reminders in the workplace/communications; and (v) culture change within the establishment or the strengthening of a safety climate.

Neutral detergent refers to a pH neutral (that is, pH 6-8) cleaning agent (see 'detergent') that increases the ability of water to penetrate organic material and break down grease and dirt. Detergents are needed to allow effective cleaning to take place.

Outbreak refers to the occurrence of disease cases in excess of normal expectancy. The number of cases varies according to the disease-causing agent and the size and type of previous and existing exposure to the agent.

Patient zone refers to the patient and his/her immediate surroundings. The zone includes all inanimate surfaces that are temporarily and exclusively designated for that patient.

Point of care refers to the place where three elements come together: the patient, the health care worker and care or treatment involving contact with the patient or his/her surroundings (within the patient zone).

Sufficient water includes water for drinking, food preparation, personal hygiene, medical activities, cleaning and laundry. Water quantity needs depend on the type of facility and services provided.

Terminal clean refers to a procedure required to ensure that an area has been cleaned/decontaminated following discharge of a patient with an infection (that is, alert organism or communicable disease) in order to ensure a safe environment for the next patient.

Wastewater refers to used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water, and any sewer inflow or sewer infiltration.

Glossary and definitions based on and adapted from definitions in: WHO Guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* in health care facilities. 2017; WHO Guidelines on hand hygiene in health care. 2009; WHO Decontamination and reprocessing of medical devices for health-care facilities manual. 2016; Global Antimicrobial Resistance Surveillance System (GLASS): manual for early implementation. Geneva: World Health Organization; 2015 (<https://www.who.int/antimicrobial-resistance/publications/surveillance-system-manual/en/>); Ontario Agency for Health Protection and Promotion (Public Health Ontario), Provincial Infectious

Diseases Advisory Committee. Best practices for environmental cleaning for prevention and control of infections in all health care settings, 3rd edition. Toronto: Queen's Printer for Ontario; 2018; Tilley E, Ulrich L, Lüthi C, Reymond P, Zurbrügg C, editors. Compendium of Sanitation Systems and Technologies. 2nd revised edition. Dübendorf (Switzerland): Swiss Federal Institute of Aquatic Science and Technology; 2014:175; WHO Environmental health in emergencies. Disease outbreaks (https://www.who.int/environmental_health_emergencies/disease_outbreaks/en/); Health Protection Scotland. Transmission based precautions literature review. Environmental decontamination and terminal cleaning. 2015 (<http://www.nipcm.hps.scot.nhs.uk/documents/tbp-environmental-decontamination-and-terminal-cleaning/>); and expert input.

INTRODUCTION

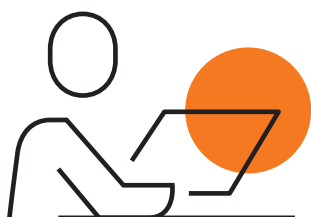
This manual presents a compelling case for action on carbapenem-resistant organisms (CROs) and describes the linkages between the prevention and control of CROs and the Global Action Plan on Antimicrobial Resistance (AMR). It describes how the eight recommendations contained within the World Health Organization (WHO) guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* in health care facilities relate to general measures (that is, the core components of infection prevention and control [IPC] programmes) that need to be in place in all countries and health care facilities to prevent and control health care-associated infections (HAIs). The use of a stepwise approach is proposed to support implementation and improvement, based on the evidence and experience of what has worked in several health care settings worldwide. The focus is on adoptable and adaptable information.

HAIs are one of the most common adverse events in care delivery and both the endemic burden and the occurrence of epidemics of HAI are major public health problems. HAIs are often caused by microorganisms that are resistant to antibiotics. AMR and HAIs have a significant impact on morbidity, mortality and quality of life and present an economic burden at the societal level. However, a large proportion of these infections are preventable by implementing effective IPC measures (1-3).

Carbapenem-resistant gram-negative bacteria, namely, carbapenem-resistant Enterobacteriaceae (CRE) (for example, *Klebsiella pneumoniae*, *Escherichia coli*), carbapenem-resistant *A. baumannii* (CRAB) and carbapenem-resistant *P. aeruginosa* (CRPsA), are a matter of national and international concern as they are an emerging cause of HAI that pose a significant threat to public health (4). **The term 'CROs' is used throughout this manual as a generic term that refers to all of these gram-negative bacteria.**

PURPOSE OF THE MANUAL

This practical manual is designed to support national IPC programmes and health care facilities to achieve effective implementation of the WHO guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, *A. baumannii* and *P. aeruginosa* in health care facilities in the context of their efforts to improve the quality and safety of health service delivery and the health outcomes of the people who access these services. The principles and guidance provided in this manual are valid for any country and include a special focus on settings with limited resources.



WHO SHOULD USE THE MANUAL?

Target audience

If you are responsible for or involved in implementing measures to improve or strengthen IPC in a health care facility with a special focus on tackling resistant organisms, this manual provides practical guidance on how to translate the WHO guidelines for the prevention and control of CROs into practice.

The main target audience of the manual is IPC leads/focal persons and teams in **acute health care facilities** (either a tertiary or secondary care facility), that is, those responsible for implementing IPC, including health care facility managers. Where these roles do not yet exist, the manual will be of interest to nurses and others responsible for IPC in the facility wards. It can also be adapted for community, primary care and long-term care facilities. The manual is also conceived to help **IPC leads/focal persons and teams working at the national level** to understand the relevance of a national plan for combating CROs and the best implementation strategies to monitor and reduce transmission in health care facilities.

It is important to note that IPC implementation is the responsibility of all health care workers and not the sole responsibility of the IPC teams. The activities outlined in this manual require a broad range of skills that can only be met through the continuous development of competencies and collaboration, as well as cooperation and engagement with a range of stakeholders and the engagement of senior leadership. Therefore, the manual is also relevant to colleagues at the health facility responsible for quality improvement, patient safety, health facility accreditation/regulation, and

public health/disease control, including those involved in the implementation and associated assessments of the International Health Regulations (IHR), water, sanitation and hygiene (WASH), occupational health, antimicrobial stewardship programmes, clinical microbiology and environmental health. In addition, it may be of value to national and district level officers and development partners/non-governmental organizations working actively in health care facilities.

CROs – THE URGENT NEED FOR ACTION

During the last 10 years, there has been an alarming global increase in CRO detection and spread. These bacteria are difficult to treat due to high levels of AMR and are associated with high morbidity and mortality. Importantly, they have the potential to cause outbreaks and contribute to the widespread transmission of resistance via mobile genetic elements (5). In particular, colonization with CROs precedes or is co-existent with infection almost universally. Early recognition of colonization is likely to help identify patients most at risk of subsequent infection, which will also allow the earlier introduction of IPC measures in health care settings to prevent pathogen transmission to other patients and the hospital environment.

IPC promotes health by keeping patients and health care workers safe from avoidable infections. The IHR identify effective IPC as a key strategy for dealing with public health threats of international concern. More recently, the United Nations Sustainable Development Goals highlighted the importance of IPC as a contributor to safe, effective, high-quality health service delivery, particularly those related to WASH and quality and universal health coverage.

There is a general consensus that in order for a health service to be of high quality, it must increase the likelihood of desired health outcomes and be consistent with professional knowledge (6). This manual supports the implementation of WHO's evidence-based guidelines for the prevention and control of CROs, thus contributing to positive health outcomes and quality health care wherever health services are delivered throughout the world.

CRO PREVENTION AND CONTROL AND LINKAGES WITH THE GLOBAL ACTION PLAN ON AMR



IPC plays a critical role for the reduction of both the spread of antibiotic-resistant organisms and the occurrence of infection. Hence, the need for antibiotic use with an ultimate impact on AMR emergence. The Global Action Plan to Combat AMR (7) was endorsed by all Member States in 2017, resulting in a commitment to develop national action plans. IPC is specifically addressed in the third of the five strategic objectives of the Global Action Plan (7). Thus, strong and effective IPC programmes in all countries and the successful implementation of the WHO guidelines on CROs are crucial for the achievement of this strategic objective.

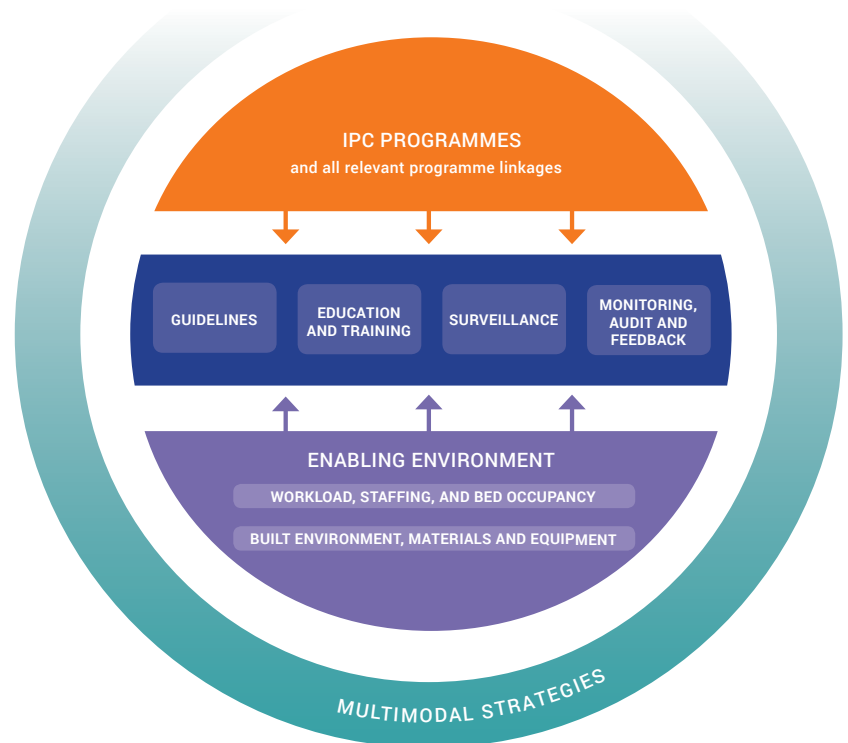
HOW CRO PREVENTION AND CONTROL RELATES TO THE CORE COMPONENTS OF IPC PROGRAMMES: A SUMMARY OF WHY ADDRESSING IPC OVERALL IS IMPORTANT



A functioning and effective IPC programme at both the national and acute health care facility level is essential for the successful prevention and control of CROs. In 2016, WHO issued guidelines that outlined the core components

of such a programme (8). These guidelines describe the key elements of an effective IPC programme and provide a 'roadmap' for all health care facilities (and countries) to successfully implement and improve HAI and AMR prevention (Fig. 1). National and facility-level manuals are available to help promote the implementation of the IPC core components (9, 10). Consultation of these previous WHO implementation manuals could be useful for readers who are not already familiar with these concepts in their efforts to improve practices to prevent or control CROs.

Fig. 1. Visual representation of the core components of IPC programmes



SUCCESSFUL IMPLEMENTATION OF THE RECOMMENDATIONS OF THE CRO GUIDELINES IS BASED ON THE EFFECTIVE IMPLEMENTATION OF ALL OF THE IPC CORE COMPONENTS

Core component 1 is particularly crucial as it is related to establishing or strengthening an IPC programme and team that provide the foundation for the successful implementation of all aspects of the prevention and control of CROs.

Core component 2 highlights the overall importance of having evidence-based IPC guidelines to define standards and best practices. The WHO CRO guidelines support IPC programmes by outlining evidence-based recommendations.

Core component 3 emphasizes the importance of conducting training for health care workers when introducing new or updated guidelines. Successful implementation of each of the CRO guideline recommendations is dependent upon training and education as part of a multimodal improvement strategy.

Core component 4 concerns the critical role of HAI surveillance to inform and guide IPC strategies and is particularly relevant to the implementation of the CRO recommendations related to surveillance.

Core component 5 is focused on multimodal improvement strategies. A multimodal strategy comprises several elements or components (three or more, usually five) implemented in an integrated way with the aim of improving an outcome and changing behaviour. This approach is described in detail in Chapter 2 and supports the implementation of all CRO guideline recommendations.

Core component 6 concerns the importance of performing regular monitoring/audit and timely feedback of health care practices. Successful implementation of each of the CRO guideline recommendations is dependent upon monitoring, audit and feedback as part of a multimodal improvement strategy.

Core component 7 reinforces the need to address workload, staffing and bed occupancy in the prevention and control of HAI. Implementation of hand hygiene, contact precautions and isolation in particular is dependent upon each of these elements as part of a multimodal improvement strategy.

Core component 8 addresses the built environment, materials and equipment for IPC at the facility level. Successful implementation of each of the CRO guideline recommendations is dependent upon each of these elements as part of a multimodal improvement strategy.

TO ILLUSTRATE THE INTERRELATIONSHIP, LET US LOOK AT THE EXAMPLE OF THE CORE COMPONENTS PROVIDING AN ENABLING ENVIRONMENT FOR IPC (FIG. 1, PURPLE SECTION)

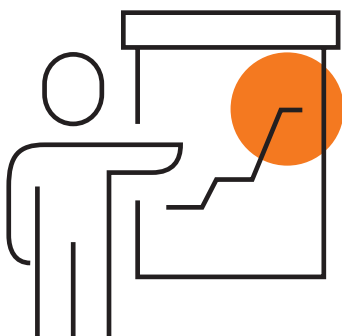
Enabling environment: adequate workload, staffing and bed occupancy (core component 7) and the necessary built environment, materials and equipment (core component 8) comprise an enabling environment for IPC practices.

Prevention and control of CROs and an enabling environment: implementation of many of the CRO guideline recommendations depends on an enabling environment. Addressing the enabling environment is essential in order to successfully implement the guidelines. For example, if your facility has gaps in water quality and availability, as well as sanitation infrastructures, the implementation of the CRO guideline recommendations related to hand hygiene, contact precautions and environmental cleaning will be at risk. In such circumstances, addressing WASH-related improvement will be a priority action for the prevention and control of CROs.

A stepwise approach: this manual reinforces a stepwise approach to implementation of each recommendation.

THE WHO STEPWISE APPROACH TO IMPLEMENTATION

WHO proposes a five-step cycle of implementation (Box 1) to support any IPC improvement intervention or programme. This approach is featured in the national and facility practical manuals (9, 10). Implementing a successful CRO IPC strategy is complex as evidence shows that an impact can be achieved only with the use of several integrated measures, that is, through a multimodal strategy. The work required to ensure that the entire facility is ready for this should not be underestimated. Of note, it cannot be seen in isolation and must be grounded within a broader IPC approach and supported by the facility's commitment to improvement and safe, quality care overall.



BOX 1. THE FIVE-STEP CYCLE TO IPC IMPROVEMENT AT THE FACILITY LEVEL

Step 1. Preparing for action: this step aims to ensure that all of the prerequisites that need to be in place for success of an IPC intervention or programme are considered. These include starting to think about the necessary resources (human and financial), infrastructures, planning and coordination of activities, and the identification of roles and responsibilities (including key opinion leaders and champions). Facility senior managers/leaders play a critical role in this step. Of note, the preparations made can be refined after conducting step 2, which provides a more precise evaluation of the needs. Furthermore, even when all of the ideal prerequisites are not fully met in step 1, it is still possible to work through the five-step cycle.

Step 2. Baseline assessment: conducting an exploratory baseline assessment of the current situation, including the identification of existing strengths and weaknesses, is critical for developing a tailor-made action plan that addresses the reality of a health care facility. A ready-to-use assessment tool based on the WHO IPC core components is available for step 2 (WHO IPC Assessment Framework [IPCAF] (11)). Ideally, additional IPC assessment tools (for example, the Hand Hygiene Self-assessment Framework [HHSAF (12)] and/or observation-based tools to evaluate IPC practices) could be used by facility and national decision-makers.

Step 3. Developing and executing an action plan: the results of the baseline assessment support the development and execution of an action plan based around a multimodal improvement strategy.

Step 4. Assessing impact: conducting a follow-up assessment using the same tools as in step 2 is crucial to determine the effectiveness of the plan. The focus is on impact, acceptability and cost-effectiveness.

Step 5. Sustaining the programme over the long term: an important step in the cycle of improvement is to develop an ongoing action plan and review schedule to support the long-term impact and benefits of the IPC programme, thus contributing to its overall impact and sustainability.

SUMMARY OF ACTIONS IN THE FIVE-STEP CYCLE AS THEY RELATE TO CRO PREVENTION AND CONTROL

Adapting the five-step cycle to implement an intervention to reduce CRO spread in your facility can be quite straightforward and represents a successful approach to improvement

Step 1. Getting ready to start a programme of work or strengthen what is already in place to improve CRO prevention and control in the facility.

- Involves a contextual reflection on the decision or need to invest in tackling this problem, identifying initial resources and conditions needed to support the successful implementation of future actions, and starting to prepare to put them in place (for example, start to consider supplies procurement and

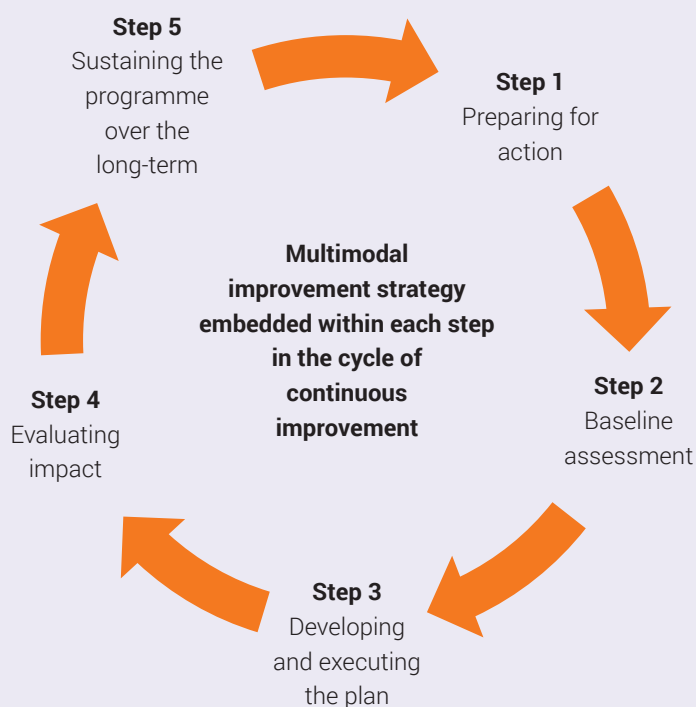
infrastructure issues, IPC programme organization, as well as any training required).

- It also involves engaging senior management, key leaders and stakeholders in order to gather their formal support to move forward with your plans – particularly in the clinical areas where CRO presents a current or potential problem. The selection of personnel to be included in the team to drive forward the plans and convincing them to be involved will be critical. It implies the establishment of links with other key programmes/services (for example, the microbiology laboratory, the pharmacy or hospital engineers) to support the sustainability of efforts. Start small, where the burden is high and impact can be measured and then build on early successes.
- Initial engagement, communications and advocacy will need to be addressed as part of this step.
- Note: this step can take months, depending on the facility. However, it

is important to note that rapid action will be required within and beyond the stepwise approach presented here during an outbreak situation.

Step 2. Conducting an exploratory baseline assessment of the current situation concerning CROs in your facility.

- This involves focusing on the CRO guidelines recommendation on monitoring/auditing and feedback (recommendation 8) and assessing what is in place to enable implementation of all IPC recommendations for CROs. This evaluation could include the following actions.
 - ▶ Conducting surveillance and/or gathering data about current levels of resistance and compliance with critical prevention practices/indicators. It is useful if data can be compiled by ward or hospital area. This forms an important part of baseline assessment.
 - ▶ Reviewing data from existing surveillance and/or monitoring of HAIs and preventive measures related to CROs if already available – underpinned by a robust understanding of epidemiology (that is, infections imported or present on admission versus transmission during hospital stay). For example, it might be useful to undertake a retrospective exercise of reviewing existing microbiology data.
 - ▶ Using the IPCAF or another relevant assessment framework (for example, WASH FIT assessment tools (13) with a focus on parts that reflect the key components for CRO prevention and control), such as section four of the IPCAF that focuses on the surveillance situation in a facility.
- A timeline for baseline assessment and reporting of results should be agreed upon.



- Importantly, plan who will receive the results and how they will be used to ensure the necessary action takes place.
- This step will clearly highlight strengths and weaknesses, risks and needs and is likely to highlight resource gaps that have not been addressed previously. In particular, it will facilitate an understanding of how these strengths and weaknesses pertain to CRO transmission specifically (for example, if CRO surveillance is not in place and you have decided to undertake a point prevalence study, this step helps to evaluate the laboratory capacity for establishing ongoing surveillance, as well as the implications in terms of financial and human resources, equipment procurement, etc.).
- Highlighting existing strengths and achievements is important to convince decision-makers and other stakeholders that further success and progress is possible.
- Identifying particularly meaningful information or pieces of data will also help with engagement, communications and advocacy.
- Note: 'assessment fatigue' is a real risk and creating ways to embed this work in existing activities/facility goals is important.

Step 3. Acting on the results of the baseline assessment.

- Develop and implement a plan of action informed by the results of your baseline assessment. Further discussion and consensus with key leaders and other stakeholders based on the baseline situation analysis may be necessary.
- Chapters 1 to 5 will help in the development of your action plan and implementation strategy specifically for CROs.
- A realistic, priority-driven action plan informed by the baseline assessment based on the local context is key.

It is important to focus initially on achieving short-term wins. Some testing of the intervention plans may be useful at this stage.

- It is important to include responsibilities, timelines, budgets and expertise/other resources needed in the action plan, as well as review/reporting dates. Resources needed may be human and/or relate to materials and equipment and many changes will be process changes impacting on a current way of working or the culture inside the organization (see Chapters 1-5 for more information and the example action plans presented in the 'Interim practical manual supporting implementation of the WHO Guidelines on core components of infection prevention and control programmes' (8)).
- Anticipate risks or unintended consequences associated with this plan and identify mitigation measures (for example, organizational implications of setting up patient isolation or cohorting, including exclusive staff dedication).
- Always seek approval for your action plan from key leaders and/or senior facility management to ensure buy-in and allocation of budgetary resources.

Step 4. Collecting evidence to determine what has worked and what gaps still remain, with the aim to measure the impact and engage critical decision-makers.

- Follow-up assessment using the same tool used for baseline assessment will enable implementation progress to be tracked. This review should involve all key leaders, stakeholders, etc. identified in previous steps.
- Your action plan can be updated during this step. For example, update priority activities and revise roles and responsibilities. If possible, an

evaluation of cost-effectiveness should be included.

- A regular and realistic schedule of evaluation should be put in place using auditing methodologies for example.

Step 5. Taking local decisions on how prevention and control activities and improvements can be sustained, as well as addressing ongoing gaps.

- This step is concerned with 'routinizing' strategies for the prevention and control of CROs.
- This may require resources.
- It is important to build on experiences or lessons learnt, current understanding of the local situation, and organization of the overall IPC programme of work in order to ensure that IPC and CRO prevention is considered a critical part of the regular business of your health facility.
- This step would also include consideration of new actions required to counteract intervention 'fatigue', for example, launching a new campaign on a certain aspect of CRO prevention.
- Be sure to build on the momentum of your work, celebrate success and maintain engagement!
- All key stakeholders will be critical in these discussions.
- Challenges associated with this step include that senior managers may disengage and/or key leaders leave the facility or move on to new projects.
- Remember to revisit all these steps systematically to keep focused on the ongoing improvement plans.

HOW TO USE THIS MANUAL

Below is a brief outline of the focus of each chapter to help you quickly and easily find the most relevant information for your needs.

Chapter 1

- Explains the relevance of the manual to those working at the national level, including key implementation considerations in low-resource settings.
- Solution-focused country examples and case studies are included to illustrate how to overcome barriers and challenges to implementation.
- The chapter concludes with a list of national-focused tools and resources.

Chapter 2

- Introduces the reader to implementation requirements specific to the facility.



A STREAMLINED APPROACH – CONDENSING THE RECOMMENDATIONS INTO THREE CHAPTERS!

The eight guideline recommendations for the prevention and control of CRO are interlinked to some extent and from an implementation perspective can be considered under three broad headings. These three headings form the three final chapters of this manual, summarized in the table below:

Table 1. Chapters 3-5 at-a-glance

	Chapter 3	Chapter 4	Chapter 5
Title	Surveillance	Contact precautions, including hand hygiene and isolation	Environmental cleaning, including surveillance cultures of the environment
Guideline recommendation(s) addressed	<ul style="list-style-type: none"> • Recommendations 1, 3, 7, 8. • Recommendation 8 is addressed within the section on multimodal strategies. 	<ul style="list-style-type: none"> • Recommendations 1, 2, 4, 5, 8. • Recommendation 8 is addressed within the section on multimodal strategies. 	<ul style="list-style-type: none"> • Recommendations 1, 6, 7, 8. • Recommendation 8 is addressed within the section on multimodal strategies.

Chapter 3

- Addresses implementation of the CRO guideline recommendations related to surveillance and screening.

Chapter 4

- Addresses implementation of the CRO guideline recommendations related to contact precautions, including hand hygiene and isolation.

Chapter 5

- Addresses implementation of the CRO guideline recommendations related to environmental cleaning.

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CHAPTER 1 – NATIONAL LEVEL APPROACH

“We will not win the fight combating HAIs and AMR without IPC. An effective IPC action at the point of care is not possible without an integrated IPC programme and dedicated champions. Whenever we could – at every relevant ministry of health meeting – we presented on IPC and advocated for its importance until we gained leadership support and grew from there.”

IPC National Lead from the WHO African Region



INTRODUCTION

The WHO guideline recommendations are clear in the actions required by all health care facilities worldwide for the prevention and control of CROs. However, this is not only a matter of importance for those working in health care facilities; national level action is essential to support implementation in health care facilities.

The WHO guidelines emphasize that CROs pose a significant threat to public health and a major challenge to countries in their efforts to strengthen IPC to keep patients and the community safe and protected from HAI and AMR. Implementation of the evidence-based IPC strategies at the health facility level as described in the guidelines is therefore of relevance to governments and policy-makers (including international agencies and partners) responsible for IPC at all levels of the health system, as well as policy-makers responsible for the delivery of national action plans for AMR and other related issues, such as WASH.

Concerted commitment and action by national level stakeholders now, has the potential to halt what many experts believe to be a looming public health crisis. This section addresses the key implementation issues to be considered by those working on national IPC programmes and strategies.

KEY IMPLEMENTATION CONSIDERATIONS FOR THE NATIONAL LEVEL

General considerations

The status of IPC and the maturity of IPC programmes at the national level will act as an important influencer of progress on the prevention and control of CROs at the health care facility level.



The interim practical manual supporting national implementation of the WHO guidelines on core components of IPC programmes (1) highlights that the development and maintenance of a functioning national IPC programme are considered to be the foundations for the implementation of all other aspects of IPC. It ensures that national leadership and the right technical expertise are in place to support all IPC activities across a country.

In the context of CRO prevention and control, the establishment of such a national programme is critical.

CRO-specific considerations

Nine CRO-specific implementation considerations relevant to the national level are addressed in this chapter.

1. National IPC programmes

- It is important to determine the status of the national IPC programme regarding the WHO core components (particularly those most relevant for CROs).
- The interim manual (1) addresses each of the five steps for implementing IPC programmes at the national level, as described in the previous section.
- Using the IPC assessment tool (IPCAT2) (2), step 2 (baseline assessment) enables a country to understand its current situation, identify the actions necessary to strengthen the IPC core components

at the national level and pinpoint gaps to guide action planning. This is critical to have a solid basis in order to take action to prevent and control CROs.

- A simple checklist is also provided to act as a prompt “aide memoire” and guide initial thinking at the national level (Annex 1).
- An important consideration is the linkage between the national IPC programme and the status of the implementation of activities for the prevention and control of CROs. In some countries and contexts, the latter may be under the auspices of the national AMR programme or the programme leading on national emergencies. The important point is to align efforts and collaborate.
- Therefore, as detailed in the national implementation manual, it is critical to establish collaboration and coordination between the IPC programme (particularly activities related to CROs) and other relevant projects and programmes (for example, quality and safety, surveillance, reference laboratories, antimicrobial stewardship, health emergencies). Indeed, the strategies to prevent and control CROs are multimodal and cut across different activities ranging from surveillance to cleaning, including WASH, which require real and continuous integration as there are many common objectives across programmes that may be functioning independently of each other. Effective collaboration can reduce wasteful duplication of effort and ensure that resources, both human and financial, are shared whenever possible.

2. Awareness-raising/advocacy

- CRO is an emerging problem that can still be controlled in most cases and needs to be tackled urgently. Raising awareness of the importance of the problem and advocating for action to prevent and control CROs is critical to achieve overall success.

- Awareness-raising and advocacy will be enhanced with clear, simple and easily understandable explanations. Translating the highly technical subject of CROs into messages that can be understood by broad audiences requires the involvement of key stakeholders and national bodies skilled in communications and campaigning (Box 2).
- Data availability is a challenge to successful advocacy (including data generation and aggregation, together with the technical complexity of the topic). However, there is a strong endorsement from international experts that this should not stop advocacy and awareness-raising in the short term.

3. Legislation/regulation and accreditation

- In some contexts, the application of national legislation and regulations can support the enforcement of guidelines and standards’ implementation at the sub-national and facility level (Box 3). The IPC core components national level implementation manual also makes specific reference to the importance of considering accountability frameworks, accreditation and monitoring, and reward systems. Surveillance data and other assessment results should be used for improvement rather than in a punitive manner, while strong accountability mechanisms should be in place to make national and local authorities (including facility leadership) responsible for the implementation of the recommendations for CRO prevention and control, as well as for other multidrug-resistant organisms.

BOX 2. POTENTIAL MODES OF AWARENESS-RAISING

There are a number of ways to increase advocacy and awareness about CRO. The following list addresses some potential actions that could be undertaken at different levels.

1. Using national mandates to raise awareness among the health care leadership and stimulate action. For example, a patient safety alert issued from a national body or a letter from the chief medical officer to all health care chief executives (or equivalent).
2. Using national expertise and resources to raise awareness among health care professionals and translate highly technical information into clear messages. For example, specific campaigns and the use of web technology to spread messages.
3. Using the power of the United Nations to escalate CRO to the highest international level. For example, securing the support of the WHO Director-General or the United Nations Secretary-General to write to countries about the importance of CRO globally or using the Interagency Coordination Group on AMR, has the potential to raise awareness and develop more resources for advocacy, such as policy briefs or brochures targeting high level national decision-makers. This will need concerted action across many countries to lobby for this to happen.

BOX 3. CASE STUDY – THE POWER OF A NATIONAL MANDATE

In response to the 2006 national outbreak of a CRO (*Klebsiella* spp.) in Israel, described at the time as a ‘silent health emergency’, two key activities took place. At that time, there was no mechanism in place at the national level for the ministry of health to detect the threat and intervene and so *Klebsiella* spp. continued to claim lives. Stimulated by the actions of a group of IPC specialists, two key actions were implemented. First, guidelines were issued ‘that became mandatory for all acute care hospitals for the effective isolation of carriers of this resistant bug’. Second, a permanent body was created at the health ministry level and invested with the statutory authority to collect data from health care institutions and to oversee the implementation of guidelines regarding CROs. With this new mandate and new guidelines in place, the ministry of health taskforce, which later evolved into the National Center for Infection Control, played an important role in bringing this increasing threat under control.

Dr Mitchell Schwaber, National Center for Infection Control, Israel

4. Governance/coordination

- The role of regional, national or sub-national bodies (including national task forces) in coordinating the engagement of key players (for example, local authorities, experts, professional societies) for the collective development of standardized surveillance/detection approaches and prevention and control guidelines for CROs, as well as for their implementation and monitoring, is essential to ensure consistency, synergies, cohesion and sustainability. The involvement of the private sector and non-ministerial governmental health providers is also critical. This coordination role is critical during both normal and outbreak situations.

5. Laboratory capacity

- The role of the microbiology laboratory in the prevention and control of CROs is crucial as screening and surveillance are needed to guide IPC measures.
- The maturity and capacity of the laboratory systems will vary across countries.
- While an ideal laboratory capacity is desirable, it is important to address what might be considered as the minimum requirements to support effective prevention and control strategies.
- For example, in resource-limited settings, it may be more cost effective from a logistics perspective to strengthen and coordinate national/regional laboratory networks.

6. Surveillance

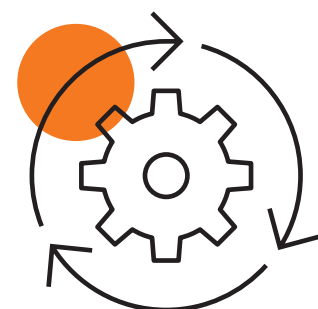
- The role of the national IPC and surveillance programmes is critical to advocate for, coordinate and enforce the surveillance of CROs. It is equally crucial to ensure access to any data. Countries must know if they have a problem and this can only be done with laboratory-based surveillance data (either ongoing or point prevalence). In particular in low- and middle-income countries (LMICs), consideration should be given to assessing the type of data needed to be available at the national level, both ideally and as a minimum. These considerations can be facilitated by the use of resources created for the implementation of the Global Antimicrobial Resistance Surveillance System (GLASS) (3) and conducted in the context of country efforts to enroll in GLASS, if possible.
- Discussions should focus on the value of point prevalence surveys versus the collection of regular data on CROs.
- Consider the analysis of AMR surveillance data and linkages to IPC as a strategic priority. For example, GLASS data should be analyzed routinely and

communication channels with IPC established to act on the data, especially for outbreaks. Data should also be used to inform on prioritization of facilities and for advocacy at higher levels.

- A number of areas warrant further attention (Box 4).

BOX 4. KEY POINTS FOR FURTHER CONSIDERATION

- No-blame culture: encourage reporting in a no-blame/non-punitive culture.
- Notifiable disease classifications: inclusion of AMR (and infections with CROs) into the notifiable diseases list or the Integrated Disease Surveillance & Response framework.
- Outbreak classification: consider whether infections/outbreaks of CROs fulfil the criteria of a public health event of international concern as per IHR reporting
- Health Management Information Systems (HMIS): are CROs routinely integrated into the HMIS?
- Roles and responsibilities: what is the role of local health authorities concerning the collection and aggregation of data, promotion of dialogue at the local level, and enhancement of local understanding and action?



7. System change

- Effective IPC interventions in health care facilities require an adequate built environment, materials and equipment. Guideline recommendations for CRO prevention and control are equally dependent on a supportive system and therefore national level actors play a role in ensuring that health facilities are supported.
- Integration of IPC and CRO prevention and control into health system strengthening and planning should be considered.
- Work to identify minimum criteria for CRO prevention and control is currently underway and will support efforts to bring all health care settings towards a minimum standard to support incremental or stepwise improvement. This work will include a focus on the development of costing models to guide national authorities in decision making.

8. Education

- Action at the facility level to prevent and control CROs depends on effective training and education of the health workforce. National IPC programmes should support education and training of the health workforce (including pre-employment and at pre- and postgraduate level) as one of its core functions within the context of a multimodal strategy and taking into account the availability of training materials in the local language.
- One critical focus of training of those in charge of IPC programmes is the ability to use and interpret the data made available by the national or local surveillance system. It is essential to spend time to critically review the data and identify appropriate actions to be made accordingly. Specific expertise is required for these tasks. If the country does not yet have this existing capacity, international training opportunities and support should be sought as soon as possible.

- The training package should be standardized across the country and ideally rolled out by national or regional authorities. The content should help health care workers to understand the epidemiology and terminology related to CROs, as well as transmission, risk assessment, detection and prevention measures.
- The national IPC programme should coordinate training activities with medical/nursing education bodies, and national or regional education accreditation agencies. Available training and education organization and opportunities should be used to embed specific training on CROs at national and regional levels.
- The WHO interim practical manual supporting national implementation of the WHO guidelines on core components of infection prevention and control programmes (1) describes the key players, curriculum development process and target audience for training and education to be successful.

9. Endemic versus outbreak contexts

- **A robust approach to IPC at the national level is essential in both outbreak and endemic situations to support the appropriate, evidence-based response to cases of CROs, once detected.**
- The linkage between data and action is critical and clear roles and lines of responsibility should be defined at each level of the health system.
- Recommendation 3 (surveillance of CRE-CRAB-CRPsA infection and surveillance cultures for asymptomatic CRE colonization) highlights the importance of screening patients with a history of recent hospitalization in endemic CRE settings.
- Detection of CRO is therefore key in all contexts and all countries, particularly actions aimed at strengthening surveillance at the national level, as detailed previously.

ADDITIONAL CONSIDERATIONS



The WHO interim practical manual supporting national implementation of the WHO guidelines

on core components of infection prevention and control programmes (7) highlights the importance of securing national, sub-national and local political commitment and presents a stepwise approach to achieve this. There are multiple examples within the manual of how this has been achieved in low-resource settings. Many examples relate to IPC in the context of AMR and are directly relevant to the implementation of national IPC measures for the control and prevention of CROs. In particular, the importance of integrating IPC with AMR and quality improvement is a key lesson learned from country case studies (Boxes 5, 6 and 7).

BOX 5. COUNTRY EXAMPLES**Country example 1**

"It is critical to link the IPC programme to the prevention of certain public health priorities, including bloodborne pathogens, such as hepatitis and human immunodeficiency virus (HIV), as well as AMR. Having a ministerial decree to establish the IPC unit is critical to define the mission and function of the unit and to allocate adequate resources".

IPC National Lead from the WHO African Region

Country example 2

"We first identified an IPC technical expert consultant to work with us to identify the key evidence-based standards and then worked internally to focus on local adaption. We met with each of the managers from the vertical disease programmes, including AMR, HIV, tuberculosis, maternal and child health care, and reviewed the inclusion of IPC principles in their guidelines so that we made sure they were harmonized with our IPC guidelines. We also used this as a way to build collaboration and relevant programme linkages (that is, sharing of technical documents and identifying joint action)."

IPC National Lead from the WHO African Region

Country example 3

"It has been helpful to take advantage of AMR work and global health security to strengthen surveillance for HAIs and integration into HMIS."

Regional IPC focal point from the WHO Eastern Mediterranean Region

BOX 6. CASE STUDY – SCALING UP SURVEILLANCE IN INDIA

"The ministry of health (with a development partner) is developing a network of hospitals to improve IPC practices, prevent HAIs, and track AMR. The major network hospital in New Delhi is coordinating the network's activities on behalf of the ministry of health. The network is first implementing bloodstream infection and urinary tract infection surveillance in a phased approach. The coordinating hospital plus four additional network hospitals were first trained in central line-associated bloodstream infection surveillance in July 2016 at a large partner-led workshop. Staff from the coordinating hospital received additional training on the surveillance protocol, suggested methods for implementation and mentorship.

The trained staff from the coordinating hospital then visited the four surveillance hospitals in October-November 2016 to provide supportive supervision and implementation guidance to ensure that the protocol was being followed consistently across sites. Laboratory practices vary by hospital and it is unlikely that all will implement the surveillance protocol in the same way, but there is consensus that it is important to ensure the consistent application of definitions across sites as the key step. Support visits will be important to ensure supervision, mentorship, assessment of data quality and use of data. The expectation is that these support visits will continue at least twice a year at all participating hospitals as the surveillance network expands."

IPC lead from an international organization working in India

BOX 7. CASE STUDY – SCALING UP SURVEILLANCE IN SENEGAL

"Regarding hygiene and infection prevention, we are still at the stage of good intentions and attempts since many years, most often punctuated by failures in sustainability. The different levels of achievements consist of: (a) the basement: with WASH indicators to satisfy; (b) the ground floor: with the standard precautions to put in place; (c) the first floor: additional precautions depending on the risk of infection; (d) the second floor: these special recommendations are more demanding in terms of human and material resource, as well as equipment and infrastructures. The current very negative situation (with a level of performance between 'basement and ground floor') is to be tempered because of the very favourable context: the states are all in the process of developing their national plans to fight against AMR, of which IPC is an integral part. Many technical tools are currently available and the use of multimodal strategies will undoubtedly bring greater efficiency to the activities undertaken, as well as the availability of technical and financial partners to support the fight against the AMR. We can be optimistic for the future, even if the past and the present have been discouraging."

Professor Babacar Ndoye, IPC expert, Senegal

IMPLEMENTATION BARRIERS AND SOLUTIONS

A number of challenges may be faced at the national level that will impact on implementation success. Table 1 lists some of the common barriers to implementation that IPC leaders have encountered at the national level, together with some potential solutions and implementation examples.

Table 1. Overcoming barriers and challenges to implementation

Potential barrier(s)	Potential solution(s)	Implementation example(s)
1. Leadership for IPC is lacking	<ul style="list-style-type: none"> Build linkages and promote integration, for example, with AMR, other directorates (such as the nursing directorate), patient safety, quality management, maternal and newborn care. 	<p>Securing leadership support by involving patient groups</p> <p>“One of the key challenges is communication and political will. We had success addressing this through patient associations, which undertook sensitization activities and training for health workers on IPC.” IPC Lead, Burkina Faso</p>
2. Lack of national IPC programme	<ul style="list-style-type: none"> Build on programmes that are established -integrate/ collaborate/embed IPC within other programmes. 	<p>Integration with other programmes</p> <p>“The IPC programme in South Africa was started at health facility level. Many IPC practitioners were trained, but because there is no career path established, many left IPC and moved to other disciplines. Recently an IPC programme has been established under the quality improvement directorate. The national IPC policy (2007) is under review (2019), in line with the WHO core components, and is linked to the Ministerial Advisory Committee on AMR, which will give visibility to the IPC programme developed according to evidence-based recommendations. This should move towards a career path for IPC practitioners, thereby strengthening health systems in this regard.” IPC physician, South Africa</p> <p>“We had a champion within the quality assurance programme who was passionate about IPC. She started by advocating for a portion of dedicated time to work on IPC and was allowed a small team from the regional health associations to do so. This team focused on constant engagement through senior meeting presentations and individual meetings with programme managers. Meetings were held to share work plans and identify joint actions. They were also able to leverage public concerns about the cleanliness of hospitals to raise awareness about the importance of IPC. They worked with facilities to convince leadership on the need for IPC focal persons that could dedicate 1-2 days per week in the beginning. With time and results, much of the dedicated time to IPC at the national and facility level grew.” National IPC Lead from the WHO African Region</p>

Table 1. Overcoming barriers and challenges to implementation, continued

Potential barrier(s)	Potential solution(s)	Implementation example(s)
<p>3. Lack of political will for action on CROs</p>	<ul style="list-style-type: none"> • Use local and global data as much as possible to demonstrate that this is a priority – focus on the impact of CROs both human and financial. For example, use patient stories and develop an economic case that describes the financial impact of HAIs generally to help increase political will and understanding of the problem. • Use social media. • Work with WHO country offices, patient organizations and scientific societies to lobby governments and policy-makers to realize that CRO is a major public health threat. • Put a face on the problem: make a case with local cases featuring real patients and health care workers. 	<p>Leverage the power of national actors</p> <p>See Box 3 describing the positive role of the ministry of health in overseeing the implementation of guidelines.</p>
<p>4. Underestimation of the problem</p>	<ul style="list-style-type: none"> • Good communication of the rising threat of CROs will be essential. Use the levers appropriate for the country. For example, the cost of controlling an outbreak versus the cost of preventive measures, as well as the potential harm to patients and the reputation of the health institution. • Give publicity to scientific articles in reputed journals (see Cassini et al. paper in Tools and Resources) so that the public health authorities and key people realize the health burden and the consequences posed by CROs. 	<p>Build on lessons learned from outbreaks</p> <p>“A recent outbreak of carbapenem-resistant <i>Klebsiella pneumoniae</i> (KPC-1) in the one public hospital of Barbados highlighted the fragility of the health care system IPC programme in the absence of trained personnel. At the start of the outbreak, IPC was only one nurse (formally untrained) at the 600-bed Queen Elizabeth Hospital in Barbados. A major restructure of the reporting structure and programme was achieved. Rapid training was carried out by first identifying key IPC champions across the institution by divisions. Intense training in hand hygiene (didactic and practical) by the new IPC physician assisted by the IPC trained nurse was carried out over the first 6 months. Administrators made the training mandatory and new staff had training in basic IPC (hand hygiene and personal protective equipment usage), now designated as an employment prerequisite. 85% of the staff cohort of 2400 persons at all levels were trained in basic IPC principles (simulation in groups of 15) with respect to hand hygiene and including appropriate auditing and feedback. Photographs of administrator participation (chief executive officer, etc.), posters (“Stop, Think, Go”), and television programmes and videos in all the patient waiting areas made by the local IPC team (familiar faces) were used to give high visibility to the “Stop, Think and Go” campaign strategy by the IPC group. IPC became a familiar face to staff, administrators and patients. Staff training expanded at the IPC departmental level and now includes three individuals supported by link champions on each ward and non-medical staff divisions. Together with the expansion in training, the administration supported postgraduate training by funding an external international Master’s programme for new staff in IPC in 2016. In resource-constrained settings, such as Barbados, it was equally important to strengthen the rapid training exercise by linking it to employment and medical school training assessment.” IPC Lead, Barbados</p>

Table 1. Overcoming barriers and challenges to implementation, continued

Potential barrier(s)	Potential solution(s)	Implementation example(s)
<p>5. Lack of personnel with expertise in IPC at the acute time of an outbreak</p>	<ul style="list-style-type: none"> • Establish a rapid train-the-trainer programme led by the national IPC team with support from excellence hospitals. • Consider seeking international support. • The results of the assessment of infection control, hospital hygiene capacity and training needs in the European Union report may provide useful information to guide action (see Tools and Resources) 	<p>National and regional support</p> <p>“During the acute time of our 2011 carbapenem-resistant <i>K. pneumoniae</i> outbreak, the IPC team didn’t have enough trained personnel to effectively implement the measures urgently needed to achieve outbreak control. The IPC team was trained and more nurses were incorporated into the team. There was strong political support and the collaboration of the Pan American Health Organization and the US Centers for Disease Control and Prevention. Selected IPC evidence-based interventions (hand hygiene, contact precautions, isolation, etc.) were provided to all health care workers with no official training in IPC practices (other than the care routine of each specialty). At the same time, the IPC team monitored that these interventions were being effectively implemented. By doing so, the new IPC team members were seen as peers and a non-punitive culture of change was quickly established.” IPC physician, Panama, in collaboration with the Pan American Health Organization and the US Centers for Disease Control and Prevention</p> <p>“Regarding leadership in IPC and antimicrobial stewardship, we can share our experience at the regional level in Emilia-Romagna (Italy). We conducted a one-year regional course for both ICP physicians and nurses coordinating the IPC team and the infectious diseases physician coordinating the AMS teams of all local health trusts of the region (4.5 million inhabitants). The course (called Janus – the Roman god with two faces) was aimed at supporting leadership for IPC and antimicrobial stewardship programmes with a focus on: analysis of the baseline situation; identification of safe practices; implementation of programmes to achieve behavioural change; build-up of surveillance systems and evaluation of the impact; build-up of effective training and communication programmes; and planning and evaluation of annual activities. The course was supplemented by seminars on issues perceived as priorities, using also interviews with international experts through videos with Italian subtitles. All participants were requested to complete a working project on issues relevant to their local context, but promoting networking across local health trusts. I consider that training programmes aimed both at IPC experienced physicians and nurses and infectious diseases’ physicians responsible for AMS are of key importance for success.” IPC Lead, Emilia-Romagna, Italy</p>

Table 1. Overcoming barriers and challenges to implementation, continued

Potential barrier(s)	Potential solution(s)	Implementation example(s)
<p>6. Lack of accepted criteria of what constitutes an IPC practitioner (especially pronounced at the physician level) and lack of universal criteria for IPC training</p>	<ul style="list-style-type: none"> • National (and international) call for action to establish a curriculum in IPC for physicians and nurses with national certification. • Strengthened collaboration and coordination with other bodies, such as quality and safety to support the call for action. • National and international support for IPC leadership for the prevention and control of CROs, that is, leadership by certified IPC specialists. 	<p>Collaborate in-country to build capacity</p> <p>“Medical specialties are regulated by common national ‘learning targets’, but there is presently no specialty on IPC and probably not one in the making either. In Tromsø (as in the rest of Norway), IPC physicians are medical microbiologists and/or infectious diseases’ physicians with an interest in IPC who qualify by working in the field. It would be nice to have access to an international training programme on IPC, but costs would be an issue in many hospitals. In order to address this issue, we have recently established a common programme for IPC nurses in Gothenburg with joint Nordic financing. Therefore, our solution has been to streamline and synergize with close partners.” Head, Microbiology Department, University Hospital of North Norway; Head, Norwegian System for AMR</p> <p>Access existing national and international training courses</p> <p>“Having no official IPC curriculum in the country, the institution relied on external public and private bodies (including the Pan American Health Organization/WHO, the Society for Healthcare Epidemiology of America, US Centers for Disease Control and Prevention, European Society of Clinical Microbiology and Infectious Diseases, American Society of Microbiology, , Association for Professionals in Infection Control and Epidemiology and local providers) using remote or in-person training to train its personnel. IPC training activities were assigned according to the health care worker’s category. For example, a course with a high load of clinical scenarios involving exposure to communicable diseases and appropriate IPC was prioritized to IPC physicians. Training in the areas of device-related infection prevention (monitoring, audit and feedback), disinfection, sterilization or cleaning were prioritized to IPC nurses. This ‘prioritization’ had the objective to cover most of the recommended IPC curriculum in the shortest period of time. Some activities were self-funded and others funded by the institution.” IPC physician, Panama</p>

TOOLS AND RESOURCES

Below are some examples of tools to support implementation that may fall under the scope of national level actors (as emerging from expert consensus meetings). These tools and resources are in addition to the implementation tools and resources available to support national implementation of the WHO guidelines on core components (<http://www.who.int/infection-prevention/tools/core-components/en/>). National actors should also be aware of the range of tools and resources to support facility-level implementation listed in subsequent chapters.

WHO and other agency tools and web links

Guidelines, toolkits, risk assessments

- National guidelines for the prevention and control of multidrug-resistant organisms in health care facilities (Hellenic Center for Disease Control and Prevention, Greece)
- Solter E, Adler A, Rubinovitch B, Temkin E, Schwartz D, Ben-David D, et al. Israeli national policy for carbapenem-resistant Enterobacteriaceae screening, carrier isolation and discontinuation of isolation. *Infect Control Hosp Epidemiol* 2018;39:85-89 (<https://www.ncbi.nlm.nih.gov/pubmed/29241475>).
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- Public Health England. Acute trust toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae (December 2013). London: Public Health England, United Kingdom (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/329227/Acute_trust_toolkit_for_the_early_detection.pdf).
* Currently undergoing revision, issue date anticipated is July 2019 for the consultation and testing phase.
- Public Health England. Toolkit for managing carbapenemase-producing Enterobacteriaceae in non-acute and community settings (2015). London: Public Health England, United Kingdom (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/439801/CPE-Non-AcuteToolkit_CORE.pdf).
*Currently undergoing revision, issue date anticipated is July 2019 for the consultation and testing phase.
- Carbapenemase-producing Enterobacteriaceae: risk assessment matrix for infection prevention and control. London: Public Health England, United Kingdom.
*Currently undergoing revision, issue date anticipated is July 2019 for the consultation and testing phase.
- Carbapenemase-producing Enterobacteriaceae management and control: questions and answers for health professionals. London: Public Health England, United Kingdom.
*Currently undergoing revision, issue date anticipated is July 2019 for the consultation and testing phase.
- National technical regulations for the prevention of AMR transmission of agents of public health importance in hospitals. Chile Ministry of Health; 2015 [Spanish] (<https://www.minsal.cl/wp-content/uploads/2015/09/Exento-n-132-Aprueba-normas-Tecnicas-de-prevencio%CC%81n-diseminacio%CC%81n-de-agentes-con-resistencia-a-los-antimicrobianos-importantes-en-Salud-Pu%CC%81blica-ARAIISP.pdf>, accessed 5 March 2019).
- National technical regulations for the prevention of AMR transmission of agents of public health importance in hospitals. Supporting documents: methodology. Chile Ministry of Health; 2015 [Spanish] (<https://www.minsal.cl/wp-content/uploads/2015/09/Metodologia-Elaboracio%CC%81n-Documento-Contencio%CC%81n-resistencia-antimicrobianos-Final.pdf>, accessed 5 March 2019).
- National technical regulations for the prevention of AMR transmission of agents of public health importance in hospitals. Supporting documents: appendix. Chile Ministry of Health; 2015 [Spanish] (<https://www.minsal.cl/wp-content/uploads/2015/09/Metodologia-Elaboracio%CC%81n-Documento-Contencio%CC%81n-resistencia-antimicrobianos-Final-Anexo.pdf>, accessed 5 March 2019).
- National Plan for Antimicrobial Resistance Prevention and Control in Health Services, Brazil, 2018 [English version] (<https://www20.anvisa.gov.br/segurancadopaciente/index.php/publicacoes/item/national-plan-for-antimicrobial-resistance-prevention-and-control-in-health-services>, accessed 18 March 2019).
- Plan Nacional para la Prevención y el Control de la Resistencia Microbiana em los Servicios de Salud, Brasil, 2018 [Spanish version] (<https://www20.anvisa.gov.br/segurancadopaciente/index.php/publicacoes/item/plan-nacional-para-la-prevencion-y-el-control-de-la-resistencia-microbiana-en-los-servicios-de-salud>, accessed 18 March 2019).
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- Clustertrack tool for visualising outbreaks of infection (<https://www.clustertrack.com>).
- Carbapenem-resistant Enterobacteriaceae control and prevention toolkit. Rockville, MD: Agency for Healthcare Research and Quality; 2014 (<https://www.ahrq.gov/sites/default/files/publications/files/cretoolkit.pdf>).
- Measures to be applied following the emergence of carbapenemase-producing Enterobacteriaceae in Belgium (High Council for Health, 2011) [in French and Dutch] (<https://ecdc.europa.eu/en/publications-data/directory-guidance-prevention-and-control/prevention-and-control-infections-1>).
- Assessment of infection control, hospital hygiene capacity and training needs in the European Union. Stockholm: European Centre for Disease Prevention and Control; 2017 (<https://ecdc.europa.eu/en/publications-data/assessment-infection-control-hospital-hygiene-capacity-and-training-needs>).

Community engagement

- WHO community engagement framework for quality, people-centred and resilient health services. Geneva: World Health Organization; 2017 (<http://apps.who.int/iris/bitstream/handle/10665/259280/WHO-HIS-SDS-2017.15-eng.pdf?sequence=1>).

Scientific literature

- Brusaferrero S, Arnoldo L, Cattani G, Fabbro E, Cookson B, Gallagher R, et al. Harmonizing and supporting infection control training in Europe. *J Hosp Infect* 2015;89:351-56 (http://medlib.mef.hr/2377/1/brusaferrero_s_et_al_rep_2377.pdf).
- Cassini A, Högberg LD, Plachouras D, Quattrocchi A, Hoxha A, Simonsen GS, et al. Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: a population-level modelling analysis. *Lancet Infect Dis* 2019;19:56-66 (<https://www.ncbi.nlm.nih.gov/pubmed/30409683>).

*In cases where no web links are provided, the national or local authorities of respective countries should be consulted to request the documents.

1. Interim practical manual supporting national implementation of the WHO guidelines on core components of infection prevention and control programmes. Geneva: World Health Organization; 2017 (<http://www.who.int/infection-prevention/tools/core-components/cc-implementation-guideline.pdf>, accessed 6 February 2019).
 2. Infection prevention and control assessment tool (IPCAT2). Geneva: World Health Organization; 2017 (<http://www.who.int/infection-prevention/tools/core-components/IPCAT2.xls>, accessed 6 February 2019).
 3. Global Antimicrobial Resistance Surveillance System: manual for early implementation. Geneva: World Health Organization; 2016 (<https://www.who.int/antimicrobial-resistance/publications/surveillance-system-manual/en/>, accessed 6 February 2019).
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CHAPTER 2. PRACTICAL IMPLEMENTATION CONSIDERATIONS FOR THE FACILITY LEVEL

This chapter introduces the foundations of some practical implementation considerations relating to a health care facility. These considerations are developed in more detail in chapters 3-5. The aim is to translate the WHO recommendations into actionable interventions and improvement practices.

Two key pillars lay the foundations for the implementation approaches presented in this manual and they should always be kept in mind by the user

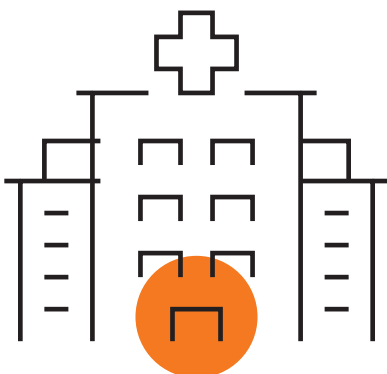
1. The WHO five-step approach to IPC improvement (presented in the introduction).
2. The WHO multimodal improvement strategy (mentioned in the introduction and presented in more detail below).

All practical suggestions should be considered within the local context. The objective is to support targeted improvement steps for each WHO CRO guideline recommendation and an overall strengthened capacity to prevent and control CROs. The use of the five-step approach to IPC improvement will allow to prioritize action according to the type and level of progress at a health care facility.

BACKGROUND TO THE WHO MULTIMODAL IMPROVEMENT STRATEGY TO SUPPORT IMPLEMENTATION OF ALL GUIDELINE RECOMMENDATIONS

The implementation approach proposed here is based on the WHO multimodal hand hygiene improvement strategy. This strategy initially proved to be effective in significantly reducing HAIs hospital-wide and to be cost effective at Geneva University Hospitals (Geneva, Switzerland) (1, 2). Its effectiveness was then proven in many other settings worldwide (3, 4). A multimodal strategy comprises several elements or components (three or more, usually five) implemented in an integrated way with the aim of improving an outcome and changing behaviour. The strategy can be supported by tools developed by multidisciplinary teams that take into account local conditions, such as bundles and checklists.

Based on field experience, expert consensus and research (5), WHO adapted the hand hygiene multimodal strategy to any IPC intervention and now proposes its use for the prevention and control of CROs.



MULTIMODAL THINKING

Scientific evidence and global experience show that an effective and sustainable impact in improving patient outcomes and health care practices through IPC interventions is achieved by integrating the implementation of different elements of the WHO multimodal strategy in a complementary and concurrent manner. Indeed, each element of the strategy is crucial and, in general, no component can be considered optional. However, the implementation strategy itself is designed to be adaptable without jeopardizing its fidelity and intended outcome. Therefore, depending on the local situation and available resources, some elements may be given more emphasis than others or may be practically implemented in different ways. For instance, a facility may have already undertaken a large-scale programme of training, but with not enough emphasis on improving the safety climate or monitoring the impact of training on actual health care practices.

The persons leading on the implementation of the guidelines for the prevention and control of CROs should therefore aim to become ‘multimodal thinkers’ and should consider the implementation of each guideline recommendation (including the potential challenges and solutions) through a multimodal lens. For example, when considering any aspect of IPC, such as developing an action plan to improve the prevention of CROs or addressing an identified gap, multimodal thinking means that the teams and their leaders should understand the following concepts, as well as systematically consider key questions that will prompt local action (Box 8).

BOX 8. FIVE KEY PROMPTS TO SUPPORT MULTIMODAL THINKING

1. What resources, infrastructures or supplies are required to facilitate practices?

This includes consideration of procurement and accessibility of supplies (including microbiology laboratory equipment and reagents), water availability and quality, and ergonomic factors including workflow. For example, adequate availability and placement of personal protective equipment (PPE) for appropriate use for contact precautions (system change/‘build it’).

2. Who needs to be trained and/or educated to address the identified gap

– how will this happen and who will undertake the training/education?

This involves written information and/or oral instruction and/or e-learning and practical and interactive training sessions, including simulation and/or bedside training. For example, the training of clinical teams dedicated to patients under isolation or cohorting due to infection or colonization with CROs (education and training/‘teach it’).

3. How have you become aware that practices need to be improved – how will you know that an improvement has taken place?

This usually involves monitoring compliance with process and practice indicators, as well as monitoring outcome indicators. For example, audits on cleaning performance and its quality (monitoring and feedback/‘check it’).

4. How will you publicize action on specific measures and promote improvement and best practice in this area?

This may involve the use of reminders, posters or other advocacy/awareness-raising tools and cues-to-action to promote an intervention and methods/initiatives to improve team communication across units and disciplines. For example, placing alerts or stickers to identify patients under contact precautions or appropriate communications during handover and patient transfer, such as using transfer forms (communications and reminders/‘sell it’).

5. How will you make and maintain this intervention a health care facility priority and engage senior leaders/managers/champions and opinion leaders over time?

This is concerned with ensuring that managers/leaders show tangible support and act as champions and role models, including making relevant decisions and promoting an adaptive approach and strengthening a culture that supports IPC, patient safety and quality. Through this strategy, teams and individuals are empowered so that they perceive ownership of the intervention. For example, discussion of local CRO surveillance data and reports about increased mortality and costs in patients affected by CRO infections to highlight the importance of the problem to decision-makers and other relevant audiences, including clinical staff (safety climate and culture of safety/‘live it’).

In summary, the use of multimodal improvement strategies supports all aspects of IPC implementation and underpins all IPC guideline recommendations (appendix 1). The WHO multimodal improvement strategy states that implementers should address the system (including resources and infrastructures), training and education, monitoring and feedback, communications and reminders, and the institutional safety climate/culture. Therefore, IPC practitioners and all those involved in supporting implementation should not focus only on single strategies to change practices (for example, training and education alone), but consider a range of strategies that target different influencers of human behaviour. The Table below summarizes the multimodal improvement strategy.

Table 2: Elements of the multimodal strategy – the ‘how’ of improvement

<p>SYSTEM CHANGE “BUILD IT”</p> 	<ul style="list-style-type: none"> • Refers to ensuring that the health care facility has the necessary infrastructure (for example, including procurement procedures and protocols) and resources (including human resources) in place to facilitate implementation of the guideline recommendation, such as laboratory capacity to support screening and surveillance. • This also includes consideration of procurement and accessibility of supplies, water availability and quality and ergonomic factors, including workflow and algorithms.
<p>TRAINING AND EDUCATION “TEACH IT”</p> 	<ul style="list-style-type: none"> • Who needs to be trained and/or educated, how will this happen and who will undertake the training/education to support the guideline recommendation? For example, the training of nurses in how to collect or support patients for the collection of rectal swabs. • This involves written information and/or oral instruction and/or e-learning and practical and interactive training sessions, including simulation and/or bedside training.
<p>MONITORING AND FEEDBACK “CHECK IT”</p> 	<ul style="list-style-type: none"> • How have you become aware that practices need to be improved? How will you know that an improvement has taken place? For example, audits of adherence with contact precautions and the provision of timely feedback of results to doctors and nurses. • This usually involves monitoring compliance with process and practice indicators, as well as monitoring outcome indicators.
<p>COMMUNICATIONS AND REMINDERS “SELL IT”</p> 	<ul style="list-style-type: none"> • How will you publicize action on specific measures and promote improvement and best practice in this area? How will information be given to patients and families? For example, the use of leaflets or website addresses provided to patients and families. • This may involve the use of reminders, posters or other advocacy/awareness-raising tools and cues-to-action to promote an intervention and methods/initiatives to improve team communication across units and disciplines.
<p>SAFETY CLIMATE AND CULTURE CHANGE “LIVE IT”</p> 	<ul style="list-style-type: none"> • How will you make and maintain this as a health care facility priority and engage senior leaders/managers/champions and opinion leaders over time? This also relates to the empowerment of teams and individuals so that they perceive ownership of the required interventions. For example, discussion of CRO cases at executive level facility meetings. • This is concerned with ensuring that senior managers/leaders show tangible support and act as champions and role models, including making relevant decisions and promoting an adaptive approach and strengthening a culture that supports IPC, patient safety and quality.

ADDRESSING EACH RECOMMENDATION

The remaining chapters of this manual are concerned with the implementation of the eight guideline recommendations:

Recommendation 1: Implementation of multimodal IPC strategies, that is, hand hygiene, surveillance, contact precautions, patient isolation (single room or cohorting) and environmental cleaning.

Recommendation 2: Importance of hand hygiene compliance for the control of CRE-CRAB-CRPsA.

Recommendation 3: Surveillance of CRE-CRAB-CRPsA infection and surveillance cultures for asymptomatic CRE colonization.

Recommendation 4: Contact precautions.

Recommendation 5: Patient isolation.

Recommendation 6: Environmental cleaning

Recommendation 7: Surveillance cultures of the environment for CRE-CRAB-CRPsA colonization/contamination.

Recommendation 8: Monitoring, auditing and feedback.

Special focus on guideline recommendation 1: Implementation of multimodal IPC strategies (interventions)

In the present context, the term ‘multimodal’ highlights the need for a combination of interventions/measures that will prevent and control CROs. For the remainder of the manual, when referring to recommendation 1, we will use the term multifaceted as a replacement for multimodal to avoid confusion with the use of the improvement term ‘multimodal’ already addressed, and widely used in other WHO implementation approaches (6). The guidelines state

that such multifaceted strategies at the very least should include: hand hygiene (recommendation 2); surveillance, particularly for CRE (recommendations 3 and 7); contact precautions (recommendation 4); patient isolation - single room isolation/cohorting (recommendation 5); and environmental cleaning (recommendation 6). As recommendation 1 refers to critical measures that are part of other specific recommendations, it is not dealt with in detail in this manual.

Special focus on guideline recommendation 8: Monitoring, auditing and feedback

Recommendation 8 outlines the need to undertake monitoring of the implementation of multimodal strategies and feedback of results to health care workers and decision-makers. Implicit within each of the preceding guideline recommendations (1 to 7) therefore is the need for monitoring, audit and feedback. In the introduction, we addressed monitoring and evaluation (‘check it’) as a fundamental element of the multimodal improvement strategy, especially for CRE-CRAB-CRPsA. For this reason, there is no specific chapter on monitoring, audit and feedback, but it is addressed specifically within Chapters 3 to 5 as highlighted in Table 3 in the context of a multimodal strategy.

BOX 9. STRUCTURE OF CHAPTERS 3 TO 5

Chapters 3 to 5 follow the same structure for ease of navigation

- A rapid recap of the purpose of each guideline recommendation.
- A table describing the practical issues relevant to each recommendation, that is, the what, why, when, who and how of each recommendation. This represents an at-a-glance outline of what a health care facility needs to have in place to meet the guideline recommendation, why this is important, who should be involved and when action should occur. The emphasis here is on actions that are considered essential and can be prioritized for action in the immediate term, in addition to those actions that can form part of a longer-term plan.
- A list of key considerations according to the multimodal improvement strategy.
- Description of a range of potential barriers and solutions when implementing each recommendation, together with some country examples and experiences. The aim is to direct local actions to prevent and control CROs. Although there is some special focus on LMICs, the strategy is meant to be useful and stimulating to achieve the improvements required in any setting, irrespective of resources. All suggestions for improvement against the WHO recommendations should be considered within the local context.
- List of tools and resources.

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6. WHO multimodal improvement strategy. Geneva: World Health Organization (www.who.int/infection-prevention/publications/ipc-cc-mis.pdf, accessed 7 February 2019).

CHAPTER 3: SCREENING AND SURVEILLANCE IN HUMANS

“While recommended surveillance and screening are still far from the capacity of most facilities in low-income countries, we have to recognize that some simple and low-cost tests could be used and thus, a system should be put in place. Starting with some pilot sites would provide local data to raise awareness and help political decision-making to prioritize this problem.”

Clinical microbiologist and
IPC specialist, Senegal



RECOMMENDATION 3

- (a) surveillance of CRE-CRAB-CRPsA infection(s) should be performed; and
- (b) surveillance cultures for asymptomatic CRE colonization should also be performed, guided by the local epidemiology and risk assessment.

Populations to be considered for such surveillance include:

- patients with previous CRE colonization/infection;
- patient contacts of CRE colonized or infected patients;
- patients with a history of recent hospitalization in endemic CRE settings.

Strong recommendation

BOX 10. PURPOSE OF THE CHAPTER

- This chapter presents some essential information and practical instructions to support and facilitate the implementation of recommendation 3.
- It reinforces some central messages on the importance of surveillance for CRO infection and screening for CRE colonization.
- It provides some guidance on the most suitable microbiological methods and tests for the detection of carbapenem resistance and carbapenemase production in settings with limited resources.

The chapter is not intended to be a comprehensive document on standards and methods for the detection of carbapenem resistance and carbapenemase production.

PRACTICAL ASPECTS

THE WHAT, WHY, WHEN, WHO AND HOW

Recommendation 3a. Surveillance of CRO infection	
WHAT	<ul style="list-style-type: none"> • Surveillance of CRO infection.
WHY	<ul style="list-style-type: none"> • Surveillance of CRO infection is important: • to define the local epidemiology of these pathogens and to understand where, when and which patients are getting ill in order to better allocate resources to areas of need and to establish and IPC measures; • to support the appropriate isolation of patients and initiation of contact precautions, other measures and appropriate treatment.
WHEN	<ul style="list-style-type: none"> • Always essential, regardless of the local prevalence of CRO/CRE and of outbreak situations.
WHO	<ul style="list-style-type: none"> • All patients with suspected signs and symptoms of an infection that could be caused by CRO (for example, bacteraemia or pneumonia), with special attention to patients most at risk, such as those housed in intensive care, transplant or haemodialysis units, or with previous multidrug antibiotic regimens, etc.).
HOW	<ul style="list-style-type: none"> • Use a multimodal improvement strategy (see Table 5) taking account of the following: <ul style="list-style-type: none"> ▸ facility-based HAI surveillance should be established according to the WHO core components practical manual (pages 75-83; http://www.who.int/infection-prevention/tools/core-components/facility-manual.pdf?ua=1); ▸ other surveillance systems may exist in the facility (for example, laboratory-based surveillance for the detection of sentinel pathogens, including multidrug-resistant organisms) and they could be considered to support CRO surveillance, if not yet included.
Recommendation 3.b. Surveillance for asymptomatic CRE colonization (screening for CRE)	
WHAT	<ul style="list-style-type: none"> • Surveillance/screening of asymptomatic CRE colonization.
WHY	<ul style="list-style-type: none"> • To define the local epidemiology of these pathogens and understand where, when and which patients are getting ill and will mainly benefit from CRE surveillance programmes (risk assessment) so as to better allocate resources to areas of need and tailor IPC measures • to support the appropriate isolation of patients and initiation of contact precautions and other measures.
WHEN	<ul style="list-style-type: none"> • <u>Always</u> in outbreak situations. • Ideally, also in endemic (high prevalence) settings in an attempt to contain the spread, although it can be challenging and should be tailored to local resources and priorities, and in low-prevalence settings to prevent further increase/spread. • When to collect samples: <ul style="list-style-type: none"> ▸ as soon as possible; commonly, on admission to the health facility or when risk exposure exists (for example, intensive care unit admission); ▸ then weekly until discharge or negativization of cultures, although the optimal frequency of testing is uncertain and should be based on local resources; ▸ testing weekly may not be necessary during the first month after carrier identification. • Consider periodic (for example, annually) point prevalence studies in settings where continuous surveillance/longitudinal screening is not possible. • Prompt processing of the samples is important. Deciding on one specific day of the week for sampling in agreement with the laboratory staff can be an option.

Recommendation 3b. Surveillance for asymptomatic CRE colonization (screening for CRE), continued**WHO**

- Patient categories to be screened according to risk assessment:
 - ▷ patients with a previously known history of CRE colonization or infection;
 - ▷ epidemiologically-linked contacts of newly identified patients with CRE colonization or infection (this could include patients in the same room, unit or ward);
 - ▷ patients with a history of recent (for example, <6 months) hospitalization in facilities where the regional epidemiology of CRE suggests an increased risk of CRE acquisition (for example hospitalization in a facility with known or suspected CRE);
 - ▷ patients at increased risk of CRE acquisition and infection (for example, immunosuppressed patients and those admitted to intensive care units, in particular neonatal and paediatric intensive care and transplantation or haematology units, etc.).
- The IPC nurse or team are usually in charge of the conduct of screening.

HOW

- Use a multimodal improvement strategy (see Tables 5 and 6) taking account of the following elements.
- Other surveillance systems may exist in the facility (for example, laboratory-based surveillance for the detection of sentinel pathogens, including multidrug-resistant organisms) and they could be considered to support CRE screening, if not yet included.
- Where to conduct screening: usually in the emergency department or pre-assessment clinic (when patients meet the above-mentioned risk categories) or upon admission to the ward (in particular, high-risk wards) or in the ward for contacts of newly-identified CRE cases.
- Types of samples to be collected: sample of faeces, rectal swab or perianal swab (the types of sample are listed in priority order of preference).
- Number of samples: minimum one culture; preferably, more than one.
- How to avoid potential harms or unintended consequences for the patient:
 - ▷ provide patient information on the problem, reasons for screening, protection of contacts and in the wider community;
 - ▷ educate health care workers to deal with the ethical implications of screening, as well as how to interact with patients and collect samples with tact and discretion.

BOX 11. ENHANCING THE USEFULNESS OF SURVEILLANCE AND SCREENING**The following conditions need to be present for surveillance and screening to be useful:**

- adequate resources to support implementation;
- clear definition of the objectives;
- appropriate sample collection approach: timeliness, clear roles and responsibilities indicating who should collect the samples, including the appropriate technique;
- reliable microbiological methods for microorganism identification and resistance detection;
- rapid return of results;
- clear actions depending on the results.

KEY CONSIDERATIONS, BARRIERS, SOLUTIONS AND IMPLEMENTATION EXAMPLES

Summary of microbiological tests for the identification of carbapenem resistance/carbapenemase production

The following considerations and indications are conceived in the perspective of feasibility and costs, especially for low-resource settings, but also taking into account reliability and the actual objectives of surveillance that aim to guide IPC measures.

Carbapenems are a class of antibiotics that belongs to the family of beta-lactams and structurally related to the penicillins. They are considered to be one of the most powerful drugs for treating bacterial infections and thus the emergence and spread of carbapenem resistance (CR) constitute a major public health concern. More precisely, the 2019 European Committee on Antimicrobial Susceptibility Testing (EUCAST) (1) and the Clinical and Laboratory Standards Institute (CLSI) (2) define CR according to breakpoint tables for the interpretation of minimum inhibitory concentrations (MICs) and zone diameters of the disk diffusion* (diameter of the bacterial growth inhibition area around ertapenem or meropenem disks) in culture media.

*EUCAST: CR in Enterobacteriaceae, *Pseudomonas* spp., or *Acinetobacter* spp. is defined as any isolate with a meropenem MIC >8 mg/L or disk diffusion diameter <16 mm, <15 mm, <18 mm for Enterobacteriaceae, *Pseudomonas* spp., or *Acinetobacter* spp., respectively (susceptible, increased exposure: MICs 2-8 mg/L); moreover, in Enterobacteriaceae, for phenotypic carbapenemase screening, a meropenem cut-off MIC >0.125 mg/L (zone diameter <28 mm) is recommended, followed by a confirmation test.

CLSI: CR in Enterobacteriaceae is defined as an isolate with meropenem MICs ≥4 mg/L (intermediate: 2 mg/L) or with disk diffusion diameters ≤19 mm (intermediate: 20-22 mm), in *Pseudomonas* spp. with meropenem MICs ≥8 mg/L (intermediate: 4 mg/L) or disc diffusion diameters ≤15 mm (intermediate: 16-18 mm) and in *Acinetobacter* spp. with meropenem MICs ≥8 mg/L (intermediate: 4 mg/L) or disc diffusion diameters ≤14 mm (intermediate: 15-17 mm).

European Committee on Antimicrobial Susceptibility Testing. Breakpoint tables for interpretation of MICs and zone diameters Version 9.0, valid from 2019-01-01. http://www.eucast.org/fileadmin/src/media/PDFs/EUCAST_files/Breakpoint_tables/v_9.0_Breakpoint_Tables.pdf
Performance standards for Antimicrobial Susceptibility testing,(2). Clinical and Laboratory Standards Institute (CLSI) document M100, 29th edition. Wayne.PA.

CR among Enterobacteriaceae, *A. baumannii* and *P. aeruginosa* may be due to a number of mechanisms. Some strains may be innately resistant to carbapenems. The main CR mechanism in Enterobacteriaceae is the production of various carbapenem hydrolyzing enzymes, that is, carbapenemases (mainly metallo-β-lactamases [IMP], *Klebsiella pneumoniae* carbapenemases [KPC], oxacillinases (OXA, for example OXA-48-like), Verona integron–encoded metallo-β-lactamases [VIM], and New Delhi metallo-beta-lactamases [NDM]. This is also true for *A. baumannii* (mainly OXA-type carbapenemases), whereas in *P. aeruginosa*, a combination of various resistance mechanisms (porin loss, efflux pumps, expression of AmpC and other beta-lactamases) is frequently involved in CR, besides the production of carbapenemases (mainly VIM and IMP-type enzymes). Carbapenemase enzymes are generally codified by genes located within mobile genetic elements (for example, plasmids, transposons) and break down most beta-lactam antibiotics, including carbapenems. Given that the ability to produce carbapenemases, especially in Enterobacteriaceae, can be transmitted between microorganisms through mobile genetic elements, identification of carbapenemase production (and not just CR) is important for establishing IPC measures (screening combined with carbapenemase confirmation) (3).

In high-income countries or high resource settings, after confirmation of organisms at species level, confirmation and identification of CP microorganisms is usually done by using antibiotic susceptibility testing using either the EUCAST or the CLSI methods. Further testing for the presence of carbapenemase enzymes or genes is done using various tests, including the use of chromogenic agar and then performing supplementary phenotypic or molecular testing especially polymerase chain reaction (PCR).

In HICs, timely detection of CR and carbapenemase production should be available in all acute care hospitals and external reference laboratories in the context of multimodal strategies for the prevention and control of CROs. Ideally, it should also be available in long-term care facilities and primary health care facilities by sending samples to an external reference laboratory.

These specialized media for culture and other methods, especially molecular detection methods, are usually unavailable or too expensive in LMICs. However, in the context of multimodal strategies for the prevention and control of CROs, the detection of CR and ideally of CP microorganisms should be available in all tertiary care hospitals. Therefore, it is essential that each country, including LMICs, makes plans and efforts to have a system to confirm these isolates in a tertiary hospital laboratory and establishes a national reference laboratory to help confirm not only all CROs, but also to provide reliable surveillance data at national level as a part of GLASS. Highlights regarding microbiological tests for settings with limited resources are summarized in Box 12.

BOX 12. MICROBIOLOGICAL TESTING FOR THE DETECTION OF CR IN LIMITED-RESOURCE SETTINGS

- Implications for surveillance of infection in LMICs: in the context of multimodal strategies for the prevention and control of CROs, detection of CR should be available in all tertiary care hospitals and at least in critical areas (for example, the intensive care unit) in secondary acute care facilities (especially in middle-income countries) and external reference laboratories. Ideally, the detection of carbapenemase production and identification of the carbapenemase type should also be done to inform IPC strategies and epidemiological situation analyses.
- Implications for screening in LMICs: screening detection of CR (and ideally of carbapenemase production) should be based on the local epidemiology and prioritize high-risk areas (for example, the intensive care unit) and/or patients (see categories mentioned above). In outbreak situations, reinforce capabilities and procedures at the facility level or send samples to a reference laboratory

The first step in the detection of CR in cultured organisms from both clinical and screening specimens is the accurate identification of Gram-negative microorganisms to the genus/species level, which is highly recommended both for the interpretation of resistance patterns and for the collection of epidemiological data. Manual identification can be easily done at low-cost in 24-72 hours by performing preliminary identification tests (for example, Gram stain, oxidase test), combined with commercial biochemical identification panels (API [analytical profile index], enterotube, RapID, Microbact™ or other

standardized methods) or in HICs or high resource settings, by automatized biochemical identification systems or matrix-assisted laser desorption/ionization time of flight mass spectrometry.

Confirmation of CR

It is important to note that no single assay can detect all the known genetic markers of carbapenem hydrolysis and each assay has limitations (4). When choosing a detection method, cost, turnaround time, test performance (sensitivity and specificity), technical expertise (with ongoing education and training in view of the rapidly changing epidemiology), availability of materials, technical support for equipment maintenance, and the information provided by the test are all factors that need to be considered. It is important to point out that when CR is identified through standard susceptibility testing using internationally accepted methods (that is, CLSI or EUCAST), additional phenotypic tests can help to identify carbapenemase production, but will not provide full information on all target carbapenemases. The identification of CR can be easy and cheap for any microbiology laboratory directly using ertapenem or meropenem disks on MacConkey or cysteine-, lactose-, and electrolyte-deficient (CLED) medium (preference to meropenem is given by EUCAST; in addition, ertapenem should not be used for *Acinetobacter spp.* and *Pseudomonas spp.* as they are intrinsically resistant to this carbapenem). For clinical and screening specimens (screening by rectal swab/faeces), CLED culture medium is preferred over MacConkey because it provides better differentiation. These methods provide results in around 24-48 hours. Use of screening rather than clinical breakpoints (according to EUCAST for meropenem in Enterobacteriales: >125 mg/L, zone diameter <28 mm) should be preferred for maximizing sensitivity as using clinical breakpoints will sometimes

miss carbapenemases, such as OXA-48-like or VIM. Growth on culture media does not allow identification of the microorganism, nor does it confirm the presence of CP. As mentioned above, full identification and confirmatory testing is required.

Table 4 presents methods for the identification of carbapenemase production that are considered most suitable in settings with limited resources.

Table 4. Laboratory methods for the detection of CR/CP organisms most suitable for low-resource settings

Method	Description of the test	Limitations	Sensitivity (%)	Specificity (%)	Turnaround time (cost in Euros)	Feasibility*
Rapidec Carba NP	<p>This is a colorimetric test to rapidly detect carbapenemase activity in Gram-negative bacteria, such as Enterobacteriaceae, <i>P. aeruginosa</i> and <i>A. baumannii</i>. The test is based on the detection of hydrolysis of the beta-lactam ring of a carbapenem molecule (imipenem). The hydrolysis acidifies the medium, changing the colour of the pH indicator (phenol red solution). The colour change is visible to the naked eye; no reading device/ equipment is required.</p> <p>It is also important to note that the Carba NP test cannot be performed if the colonies are grown from selective culture medium (plates containing antibiotics or other agents that select for certain bacteria, for example, MacConkey and CLED) and does not allow reliable identification of all carbapenemase types (low sensitivity for OXA-48). It cannot be used for <i>A. baumannii</i> due to poor sensitivity.</p>	<p>It rapidly identifies Enterobacteriaceae carbapenemase activity, specifically, the variants most commonly found worldwide today: KPC, NDM, VIM, IMP and OXA-48. However, it has low sensitivity for OXA-48.</p>	82-98 (5, 6)	78.9-97.8 (7)	2-3 hours (7)	++
Chromogenic agar	<p>This relies on colour interpretation of colonies.</p> <p>Test very easy to read and various manufacturers produce chromogenic agar.</p>	<p>Chromogenic medium detects CR bacteria on a large variety of carbapenemases producing organisms, including KPC, NDM, VIM, IMP, and OXA-48.</p>	<p>100 (7)</p> <p>73 -100 (8)</p> <p>Sensitivity and specificity vary greatly depending on the manufacturer and types of enzyme detected.</p>	<p>~ 70 -90</p> <p>Sensitivity and specificity vary greatly depending on the manufacturer and types of enzyme detected.</p>	<p>18-24 hours (~ 1)</p> <p>depending on the manufacturers</p>	++

Method	Description of the test	Limitations	Sensitivity (%)	Specificity (%)	Turnaround time and cost in €	Feasibility*
NG-Test CARBA 5	Multiplex immunochromatographic assay allowing identification of KPC, OXA-48-like, NDM, VIM and IMP, but not the various OXA-type enzymes in <i>A. baumannii</i> .	The assay detects KPC, OXA-48, NDM, VIM and IMP carbapenemases. Interpretation of the results can be subjective, especially when the colour is not clear cut.	97 (9)	93 (9)	Rapid test: ~15 minutes (15-20)	++
Modified carbapenem inactivation method (mCIM)^{10,11}	Method based on incubation of a meropenem (10 µg) disc in a suspension of the isolate to be tested, followed by incubation of the meropenem disc on a lawn of the <i>E. coli</i> ATCC 25922 strain and incubated for 2 hours. The meropenem disc is then removed and placed on a Mueller-Hinton agar plate that is streaked with a susceptible laboratory strain of <i>E. coli</i> ATCC strain 25922 and incubated for 6 hours at 35°C.	This is a simple, easy, rapid and low-cost method and does not require specialized equipment reagents or skills. This method showed high concordance with results obtained by PCR. It allows easy and rapid identification of carbapenemase activity in Enterobacteriaceae and <i>Pseudomonas</i> spp. (KPC, NDM, VIM, IMP, IMI, SPM, SME and OXA-type).	91 (6) (80% of OXA-48-types, 83% of IMP producers, 91% of KPC and 92% of NDM producers, and 92% of NDM producers.	99 (6)	8-9 hours (1)	+++

Method	Description of the test	Limitations	Sensitivity (%)	Specificity (%)	Turnaround time and cost in €	Feasibility**
GeneXpert (Xpert Carba-R)	<p>The GeneXpert CarbaR cartridge, based on a multiplex real-time PCR method, can be used for the detection of carbapenemase genes directly in clinical and screening specimens, but it can also be used to rapidly detect the presence of gene sequences associated with carbapenemase production in Enterobacteriaceae, <i>P. aeruginosa</i>, and <i>A. baumannii</i> grown on culture media.</p> <p>The Xpert Carba-R test performs well for the respective targets in the assay (KPC, NDM, VIM, IMP and OXA-48). There are resistant phenotypes that may not match up with the tested genes; thus, absence of identification of resistance genes with GeneXpert does not mean absence of CR.</p>	<p>Equipment is often available in LMICs for rapid detection of multidrug-resistant <i>Mycobacterium tuberculosis</i>. Thus, where the equipment exists and is well functioning, it could be also used for the rapid detection of the presence of gene sequences associated with carbapenem non-susceptibility. Unfortunately, the procurement of reagents/ cartridge, the cost, regular supply of materials and training of the laboratory staff can represent significant barriers. Expensive and requires special equipment and expertise to perform; not in widespread use.</p>	98 -100 (8)	100	~ 1 hour (expensive? cost may vary locally)	+

*Based on laboratory capacity required and costs: from + (low) to ++ (intermediate) to +++ (high)

NB: Tests for identification of the specific carbapenemase type in CRAB are based on molecular methods.

Use of the modified cloverleaf (Hodge) test is not recommended as results are difficult to interpret, specificity is poor and, in some cases, the sensitivity is also suboptimal.

Timely reporting

For both HICs and LMICs, appropriate specimen management and timely and effective reporting of the results of CRO surveillance and screening is critical. Results should be communicated as soon as possible to clinical staff (primarily for clinical cultures) and also to IPC and surveillance staff (maximum 2 days turnaround should be the goal). Consideration should be given to the use of smart phones/applications to optimize reporting time. Importantly, standardized guidance for specimen management (including specimen collection), processing for transport, storage and transport should be available in all facilities. Microbiological methods and communication channels should be standardized and streamlined. Time for transporting the samples from the clinical areas to the laboratory should also be minimized. A specific system for the transport of microbiological samples should be in place in the facility (for example, using aids) and strengthened during outbreaks. Facility-specific SOPs and training is also needed to achieve timely reporting.

Ideas to optimize reporting time and communications

- Use the *telephone* for the timely communication of results preceding the formal written report.
- Use *e-mails* or the *electronic record system* for rapid dissemination of the formal written report.
- Accurate handover between wards or hospitals or from hospitals to the community/primary health care facilities (for example, using dedicated transfer forms, see examples in Tools and Resources).

Cost and cost-effectiveness of surveillance and screening

As noted above and in the WHO guidelines (3), cost implications of CRO/CRE surveillance and screening are a major barrier to implementation of the recommendations promoted by WHO and others. Even in HICs, financial issues influence the choice of microbiological tests to be used, especially for CRE screening and when there are implications for reimbursement in the health system financing. However, in the above sections, low-cost solutions are pointed out, which should be considered and highlighted to decision-makers, in particular when resources are limited. Furthermore, there is emerging evidence that CRE surveillance is cost-effective, even in non-endemic settings (12). The benefit of surveillance for multidrug-resistant organisms is considerable when IPC is implemented accordingly and prevented transmissions are included in the cost estimate (13). This evidence should also be used for making facility business plans and convincing senior managers and colleagues.

Table 5 should be read in conjunction with the explanations and details of the WHO multimodal improvement strategy provided in Chapter 2. It provides a summary of actions to consider when implementing the recommendation on cleaning in a practical way. These are suggestions that might be effective in achieving sustainable improvement, but they require local decision-making according to the facility's needs and goals.

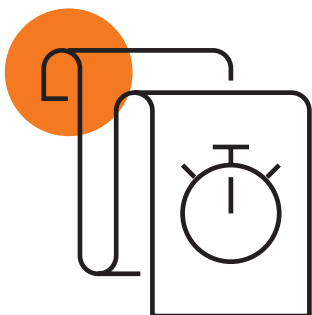




Table 5. elements of the multimodal strategy – the ‘how’ of improvement – screening and surveillance

<p>SYSTEM CHANGE “BUILD IT”</p> 	<ul style="list-style-type: none"> • Put in place/improve laboratory capacity and diagnostic stewardship to reliably detect CR and carbapenemase production. • Put in place/improve a sustainable system to reliably procure and deliver microbiology laboratory equipment tests and reagents. • Develop SOPs describing appropriate procedures for surveillance and screening. Reinforce capabilities and procedures for sample management and (if needed) sample storage and transport to a reference laboratory (off-site). • Align and link surveillance systems with GLASS, including use of standardized definitions.
<p>TRAINING AND EDUCATION “TEACH IT”</p> 	<ul style="list-style-type: none"> • Assess local training needs especially for sample collection and CRO identification in the laboratory and antibiogram interpretation. • Put in place/improve a reliable mechanism for producing/using updated training resources and information for staff on these recommendations with a focus on: <ul style="list-style-type: none"> ▸ the importance of diagnostics and diagnostic stewardship; ▸ most appropriate laboratory methods for CR and carbapenemase production detection; ▸ specimen collection, management (processing-storage-transport); ▸ use of microbiological results to establish appropriate IPC measures. • Promote clinical discussion on the importance of surveillance and contact tracing for the early detection and control of spread and outbreaks.
<p>MONITORING AND FEEDBACK “CHECK IT”</p> 	<ul style="list-style-type: none"> • Put in place/improve a monitoring, reporting and feedback mechanism (including roles and responsibilities) regarding: <ul style="list-style-type: none"> ▸ reliable availability of microbiology laboratory equipment tests and reagents; ▸ compliance with surveillance and screening SOPs/protocols; ▸ documentation processes (including degree of Clinical Microbiology Laboratory [CML] utilization), adherence to surveillance, isolation and treatment guidance relevant to safety climate and culture change. • Conduct regular point prevalence studies (especially in LMICs) if longitudinal screening for CRE is not yet in place. • Document process improvement and monitor efficiency of the surveillance system. • Consider how to engage health facilities to utilize surveillance results to inform treatment guidelines and put in place antibiotic stewardship programmes.
<p>COMMUNICATIONS AND REMINDERS “SELL IT”</p> 	<ul style="list-style-type: none"> • Identify and put in place effective and rapid mechanisms to communicate about a patient's colonization/ infection status at the point of care, for example, electronic reminders/alerts, other flagging systems (on admission/discharge/readmission), taking account of the need to address cultural aspects and local languages. • Use data from surveillance to communicate about the importance of the problem and of action for improvement (for example, if there is no ongoing surveillance and screening system, perform annual point prevalence studies and use the results to communicate and remind health care workers and hospital managers about CRO). • Flag the CRO infection/colonization status of the patient in the clinical chart or the electronic record and link it to IPC activities and antibiotic therapy prescription for appropriate action Disseminate the results of screening once available. • Highlight unnecessary screening as surveillance activities and subsequent isolation and contact precautions can involve potential harms or unintended consequences for the patient with ethical implications (effective communication is paramount).
<p>SAFETY CLIMATE AND CULTURE CHANGE “LIVE IT”</p> 	<ul style="list-style-type: none"> • Discuss the problem of CROs with senior management by providing data on epidemiology and costs, but also patient stories, to highlight it as a serious patient safety issue that requires tangible action - first of all in the ability of the facility to reliably detect it. • Motivate senior clinicians and nurses to follow SOPs for surveillance and screening by explaining the importance of the problem and the implications of surveillance for prevention and control as well as for correct antibiotic treatment. • Identify champions to promote and role model SOPs for surveillance and screening.

A number of challenges/barriers may be faced that will impact on implementation success. Table 6 lists some of the common barriers to implementation that IPC practitioners have encountered, together with some potential solutions. Implementation examples provided are focused (not exclusively) on low-resource settings. The table content elements are grouped according to the WHO multimodal improvement strategy.

Table 6. Potential barriers and solutions (screening and surveillance in humans)

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • Lack of AMR surveillance system in place in a tertiary care facility in LICs. • Limited microbiology laboratory capacity including staff. 	<ul style="list-style-type: none"> • Make a strong case for surveillance by developing a business plan. • Present real-life patient cases to hospital administrators and finance departments to build a strong case for investment on AMR surveillance and request them to interact with the ministry of health to ask to give support for some research studies on CRE epidemiology for the short term and for a sustained surveillance system as a long-term solution. This solution is not suitable for outbreak situations. • Start small – build microbiology capacity using simple techniques in the beginning. • Especially in an outbreak situation when the facility does not have a microbiology laboratory, maximize use of a central or external laboratory (for example at national or district level). • Conduct a point prevalence study using a central or external laboratory to demonstrate the importance of the problem, use the result to estimate the cost of CRO in the hospital. • If local data are not available at all, discuss surveillance data from neighbouring healthcare institutions with a similar background or, as an alternative, discuss national or published data referring to the country. • Link surveillance and screening procedures to accreditation, process (and structural) indicators, other incentives for managers; however, this has to be a regional/national initiative, but IPC teams can lobby on a national scale for this purpose (for example, through a professional association). 	<p>Start small – focus on point prevalence surveys</p> <p>“There is an urgent need to face a great threat to public health which is represented by CRE, before it becomes too late. We know that establishing surveillance is not easily applicable at present in the vast majority of tertiary care facilities in our country. But this cannot justify us to be inactive, we have to immediately do what is feasible under the current conditions, with the aim of gradually implementing all the recommendations for the surveillance and prevention of CR bacteria. In our setting we decided to start with some research projects (for example, a point prevalence study) to understand at least the magnitude of the problem.” Clinical microbiologist and IPC specialist, Senegal</p> <p>Connect with regional/national programmes where they exist</p> <p>“If a regional/national approach is not in place, the absence of surveillance in some health facilities will inevitably cause transferring undetected colonized or infected patients to the community and other facilities. The regional surveillance system may identify these sentinel events and act to contain them.” National IPC lead, Italy</p>

Table 6. Potential barriers and solutions (screening and surveillance in humans, continued)

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • Inability to effectively use surveillance or screening data for IPC action due to lack of expertise in data interpretation and lack of reporting mechanisms and effective feedback. 	<ul style="list-style-type: none"> • Ask guidance on surveillance data interpretation and use from national IPC and AMR focal points and experts, as well as local microbiology laboratory colleagues. • Conduct regular meetings with senior management to report back on surveillance data about CROs and IPC measures established. • Identify and use real-life sentinel events of overlooked cases causing secondary transmission to promote surveillance and increase hospital administration awareness. • Establish a monthly meeting with the head and staff on each unit under surveillance separately to feedback the result. • Build strategic partnerships with and between stakeholders to guarantee the timely and proper information flow. 	<p>The power of routine, timely feedback</p> <p>“There is regular surveillance and feedback from the laboratory at both health care facility and national level. This information is passed onto the IPC team daily who then investigate it further. The managers are informed immediately of any multidrug-resistant organisms and a meeting is called with the clinicians and managers to discuss the way forward. Decisions are made and implemented within the confines of effective clinical practice. It works most times, but takes a while to get the message across particularly if there are budgetary implications.” Lead, Infection Control Africa Network, South Africa</p> <p>“The Israeli national system of real-time reporting of CRE incidence and carrier prevalence from all acute and post-acute care hospitals to a central source, allows for the oversight of timely communication between relevant healthcare providers of patient carrier status.” National IPC lead, Israel</p> <p>“We created a surveillance team in the facility with specific terms of reference, including responsibilities for the earlier identification of patients to be tested, timely communication to the wards, and interaction with the IPC team to establish appropriate measures. The hospital IPC committee also plays its role by involving all the managers of the facility including the administrator and the medical superintendent.” Lead IPC nurse at a tertiary care facility, Ghana</p>

Table 6. Potential barriers and solutions (screening and surveillance in humans, continued)

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • Defective communication/ organization of work related to the identification of CRO carriers and infected patients (especially between IPC team, microbiology laboratory staff, attending physicians and nurses and hospital administrators/managers). 	<ul style="list-style-type: none"> • Clear indication of patient risk groups to be targeted for screening in national/regional guidelines. • Develop an information flowchart that needs to be followed upon identification of a CRO case. • Require recording of CRO carrier/infection status in the medical record, listed among active problems on the first page. • Require hospitals to have a mechanism in place to inform patients, general practitioners and community doctors of surveillance results issued both during hospital stay and after patient discharge. • Consider using telephones/mobile applications for optimizing reporting time. • Requiring hospitals to have defined IPC units, headed by qualified IPC physicians (see Chapter 1, Table 1, potential barrier #5), whose job description includes responsibilities including regular communication with hospital administration on CRO surveillance results and IPC measures put in place. 	<p>Develop clear roles and responsibilities</p> <p>“Despite having a microbiology laboratory with identification capabilities to the species level (and, with some regularity, to the CP status) during our outbreak, the implementation of the IPC measures required upon the identification of a CRO used to be delayed due to the lack of integration of surveillance activities performed by different stakeholders. After a couple of meetings, the stakeholders agreed on the following: (1) upon a CRO identification, the microbiology laboratory was responsible to notify the patient’s ward (usually to nursing staff) and the IPC team; (2) the nursing staff was in charge of notifying the attending physician, who was responsible to put in place any therapeutic measure; (3) the IPC team was responsible to check if all IPC measures were recommended and implemented and, if not, to take appropriate corrective measures. During weekends and holidays, a daily 8-hour surveillance shift (usually from 7am to 3pm) was established to continue these activities in an uninterrupted fashion.” Hospital epidemiologist, Panama</p>
<ul style="list-style-type: none"> • Lack of staff compliance with SOPs for CRO surveillance. 	<ul style="list-style-type: none"> • Provide regular feedback of local CRO epidemiological data along with explanations about their linkage to IPC measures. • Provide regular feedback of local data on staff compliance with surveillance SOPs. • Develop educational packages to explain how to undertake surveillance, including practical instructions on identification of patients at risk, sample collection, transport and processing. • Use of incentives and disincentives according to local culture (for example, link to annual performance evaluation). 	<p>A multidisciplinary approach</p> <p>“Due to lack of human resources and the hospital size (approximately 900 beds), during the emergency of an outbreak it was decided to assign the screening activities (rectal, perirectal, axillar, inguinal, nasal swabs) to the attending personnel (MD, medical intern or registered nurse) who was trained in screening techniques; while the IPC team (doctors and nurses) remained in charge of monitoring, audit and the feedback of protocolized surveillance activities.” Hospital epidemiologist, Jamaica</p>

Table 6. Potential barriers and solutions (screening and surveillance in humans, continued)

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • Lack of engagement in IPC by senior managers/leaders, resulting in low financial support for AMR surveillance. 	<ul style="list-style-type: none"> • Make a strong case for IPC to control CRO by developing a business plan. • Undertake or summarize cost-effectiveness studies to show the benefit of surveillance and IPC to control CRO spread. • Exploit the mainstream media in getting the message out, for example, interviews with responsible and competent health reporters, opinion editorials by IPC professionals, press releases, etc. Media can help mobilize public opinion and provide a focus on which hospitals need to dedicate more resources to IPC. 	<p>Use of electronic platforms</p> <p>“After a comprehensive restructuring of the hospital’s IPC programme and having overcome the 2011 KpKPC outbreak, the hospital faced new challenges. As new national mandatory regulations came out, more hospital areas were included in routine surveillance, with the consequent increase of stratification levels for specific and monthly analysis. With 900-hospital beds, the manual calculation of epidemiological indicators was taking too much time by the IPC team and, despite all efforts, there were always involuntary errors introduced by human mistakes. Looking for solutions, a research grant was submitted to the National Secretariat for Technology and Innovation with the objective to design, develop and implement an electronic platform to collect and analyse HAI surveillance data to direct surveillance-driven interventions. This platform was designed by the hospital for the hospital, so it is a custom-made electronic solution to a complex phenomenon. The grant was allocated to our institution and it is in its final phase of implementation and already saving time for the IPC team that is using it in prevention activities. The platform was also based on meeting mandatory national regulations standards, so it serves also as a reporting tool.”</p> <p><u>Hospital epidemiologist, Panama</u></p>

BOX 13. CASE STUDY – THE POWER OF LOCAL SURVEILLANCE DATA

"We are in a period of construction and this construction will have to be done gradually by respecting certain logical steps, at least in the main lines. However, on the other hand, there is an urgent need to face a great threat to public health, even if these new recommendations are generally not easily applicable at present in the vast majority of health establishments in our countries. It will therefore be a question of continuing the 'construction', but while doing what is feasible under current conditions, with the aim of gradually implementing all the recommendations for the surveillance and prevention of these CR bacteria. The proposed approach will therefore be based on two objectives: (1) rapidly disposing of local data to serve as advocacy and, at the same time, as a base for the conduct of prevention activities; (2) gradually building a sustainable and effective national surveillance system. Doing what is feasible and relevant, even if it will have to be done gradually according to local possibilities is: (a) setting up some pilot sites: well-chosen level 3 hospitals where prevalence studies could be conducted after a period of capacity building (with technical support from partners such as WHO); (b) enrolling the country into the global surveillance system (GLASS) including the appointment of a coordination centre and a national reference laboratory, all linked to pilot sites becoming sentinel sites; (c) adding monitoring of CR resistant bacteria to the list of targets at sentinel sites; and (d) gradually expanding the pilot sites to other levels of the health pyramid for national surveillance."

Professor Babacar Ndoye, WHO Senegal

TOOLS AND RESOURCES

WHO and other agency supporting tools already available

- ECDC-Carbapenem-resistant Enterobacteriaceae rapid risk assessment (<https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/carbapenem-resistant-enterobacteriaceae-risk-assessment-april-2016.pdf>).
- ECDC-Carbapenem-resistant *Acinetobacter baumannii* in healthcare settings. Rapid risk assessment, (<https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/8-Dec-2016-RRR-Acinetobacter%20baumannii-Europe.pdf>).
- England (Public Health England). Acute trust toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/329227/Acute_trust_toolkit_for_the_early_detection.pdf).
- Germany. Mandatory notification of carbapenem-resistant gram-negative bacteria (https://rp-giessen.hessen.de/sites/rp-giessen.hessen.de/files/content-downloads/2015_Hygiene-Medizin_Hauri.pdf).
- Ireland - SAOLTA. National carbapenemase-producing Enterobacteriaceae reference laboratory users guide (<https://saolta.ie/documents/national-carbapenemase-producing-enterobacteriales-cpe-reference-laboratory-users-guide>).
- Poland. CPE. Case definition (<http://antybiotyki.edu.pl/pdf/Definicja%20przypadku%20CPE.pdf>).
- Poland. Detection of carbapenemases- recommendation 2015 (http://antybiotyki.edu.pl/pdf/Wykrywanie%20karbapenemaz_Zalecenia%20KORLD_2015.pdf).
- Poland. Procedure how to perform culture for identification CPE in outbreak situations (<http://antybiotyki.edu.pl/pdf/Procedura%20badania%20przesiewowego.pdf>).
- Poland. Test CARBA NP and CarbACINETO for identification of carbapenemases, produced by gram negative bacteria Enterobacteriaceae, *Pseudomonas* and *Acinetobacter* (http://www.antybiotyki.edu.pl/pdf/Test%20CARBA%20NP_KORLD_2015.pdf).
- Scotland. Standardisation of testing for carbapenemase producing organisms (CPO) in Scotland (<http://www.hps.scot.nhs.uk/resourcedocument.aspx?id=6464>).
- Sweden. Recommendation for laboratory diagnostic and screening of carbapenemase-producing gram negatives (https://thl.fi/documents/10531/163131/Rekommendation_för_diagnostik_av_karbapenemasproducerande_bakterier_v1.0.pdf).
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- United Kingdom. Electronic reporting system. Enhanced surveillance of carbapenemase-producing gram negative bacteria. NHS trust and microbiology laboratory user guide (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/656134/electronic_reporting_system_ERS_user_guide_trust_micro.pdf).
- United Kingdom. Electronic reporting system. Enhanced surveillance of carbapenemase-producing negative bacteria. Data collection manual (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/536988/ERS_Data_Collection_Manual_v0_2.pdf).
- United Kingdom. UK standards for microbiology investigations. Detection of bacteria with carbapenem-hydrolysing beta-lactamases (carbapenemases) (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/554654/B_60i2.1.pdf).
- United Kingdom. Example of Patient Transfer Form, included on page 26 of Acute trust toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae (see previous)
- USA. Multiplex real-time PCR detection of *Klebsiella pneumoniae* carbapenemase (KPC) and New Delhi metallo-beta-lactamase (NDM-1) (<https://www.cdc.gov/hai/pdfs/labsettings/KPC-NDM-protocol-2011.pdf>).
- Clustertrack tool (freely available at <https://www.clustertrack.com/>).

Current gaps in tool availability

There are a number of areas where the development of new tools is considered to be useful in supporting successful implementation. These tools could be developed at the international, national or local level and this manual aims to stimulate action to address these gaps. The following list highlights tools that have been identified for priority development.

Tools to support system change

- Practical algorithm tool to support decision making (for example, decision-making tree) for when to screen and who (including carriers) guided by the local epidemiology and context.
- SOPs describing appropriate procedures for surveillance and screening (which patients, who initiates, what media, what confirmatory microbiological tests).
- Standardized forms for screening and for samples collection management and results.

Tools to support training and education

- Tool to inform how to appropriately collect specimens, the site and frequency.

Tools to support monitoring and feedback

- Humans: checklists to monitor the proportion of screened patients among those eligible.
- Tools to ensure that laboratory and surveillance results are disseminated once available.
- Guidance on how to present the data.
- Tool for outbreak tracing.
- Tool to verify that those identified by IPC staff as needing screening (ward staff) do in fact get screened – verification tool (also linked to isolation).
- Annual point prevalence studies as monitoring tools of prevalence of CPE in humans in LMICs.

Tools to support communications and reminders

- Dedicated forms for handover when patients are transferred between wards or hospitals or to the community/primary health care facilities.

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CHAPTER 4: CONTACT PRECAUTIONS, INCLUDING HAND HYGIENE AND ISOLATION

“Prevention and precautions are better than cure.”

Clinical microbiologist and infection control consultant, India [adapted from Hippocrates, 460 – c. 370 BC]

RECOMMENDATION 2: importance of hand hygiene compliance for the control of cre-crab-crps: Hand hygiene best practices according to the WHO guidelines on hand hygiene in health care should be implemented.
(Strong recommendation)

RECOMMENDATION 4: contact precautions: Contact precautions should be implemented when providing care for patients colonized or infected with CRE-CRAB-CRPsA.
(Strong recommendation)

RECOMMENDATION 5: patient isolation: Patients colonized or infected with CRE-CRAB-CRPsA should be physically separated from non-colonized or non-infected patients using (a) single room isolation or (b) by cohorting patients with the same resistant pathogen.
(Strong recommendation)



Contact precautions, isolation and hand hygiene form a triad of interventions/practices that are considered as critical for the prevention and control of CROs.

BOX 14. PURPOSE OF THE CHAPTER

- This chapter focuses on three of the WHO guidelines recommendations that relate directly to the patient, their placement within a hospital ward, and the type of precautions performed by health care workers, including hand hygiene.
- It presents some essential implementation-related information on these three interlinked recommendations in relation to isolated cases of CROs and outbreaks.
- The chapter should be considered in conjunction with standard precautions' protocols and associated implementation strategies and resources that apply to all patients, irrespective of infection or colonization status (Box 15).
- The reader's attention is drawn to the fact that distinctions between contact precautions and isolation/cohorting throughout the chapter are in fact artificial to some extent. These interventions are interrelated from an implementation perspective and a stepwise approach that builds upon available basic IPC resources will support effective implementation and patient safety.

PRACTICAL ASPECTS

THE WHAT, WHY, WHEN, WHO AND HOW

	HAND HYGIENE	CONTACT PRECAUTIONS	ISOLATION & COHORTING
WHAT	<ul style="list-style-type: none"> Hand hygiene at the right moment ('Five Moments', see Tools and Resources), using the right product and the right technique ('How to handrub' and 'How to handwash', see Tools and Resources) (alcohol-based handrub at the point of care facilitates hand hygiene in most circumstances). 	<ul style="list-style-type: none"> Mainly concerns the use of PPE (with an emphasis on gowns and gloves), hand hygiene, dedicated or disposable equipment, limitations on patient transport/movement and prioritization of cleaning and disinfection of patient rooms (see chapter 5). 	<ul style="list-style-type: none"> Mainly concerned with patient placement, that is, the physical separation of patients colonized or infected with CROs from non-colonized/infected patients using: (a) single room isolation; or (b) cohorting patients with the same resistant pathogen (see Box 16).
WHY	<ul style="list-style-type: none"> Evidence reinforces that implementation of hand hygiene at the right moments and using the right technique will have a beneficial impact on the prevention and control of CROs. 	<ul style="list-style-type: none"> Considered as standard of care for patients colonized or infected with CROs in the vast majority of health systems and the main approach to effective prevention and control. 	<ul style="list-style-type: none"> Evidence shows the importance of separating colonized/infected patients from non-colonized/non-infected patients to reduce cross-transmission, including separating patients with different resistant organisms.
WHEN	<ul style="list-style-type: none"> According to the WHO 'Five Moments' approach (see Tools and Resources). 	<ul style="list-style-type: none"> Standard of care for patients colonized or infected with CROs (in the vast majority of health systems). Pre-emptive isolation/cohorting and use of contact precautions may be necessary in some situations until the results of surveillance cultures for CROs are available. Patients with a history of recent hospitalization in regions where the local epidemiology of CRE suggests an increased risk of CRE acquisition 	<ul style="list-style-type: none"> Always in an outbreak situation Pre-emptive isolation/cohorting and use of contact precautions may be necessary in some situations until the results of surveillance cultures for CROs are available (for example, patients with a history of recent hospitalization in regions where the local epidemiology of CRE suggests an increased risk of CRE acquisition).
WHO	<ul style="list-style-type: none"> Health workers, patients and relatives (if considered close contacts). 	<ul style="list-style-type: none"> Any person caring for patients with CROs. Any health care workers with a potential contact with patients with CROs is required to use contact precautions. 	<ul style="list-style-type: none"> Patients with CRO colonization/infection
HOW	<ul style="list-style-type: none"> Use multimodal improvement strategies (see Table 7). 	<ul style="list-style-type: none"> Use multimodal improvement strategies (see Table 7). 	<ul style="list-style-type: none"> Use multimodal improvement strategies (see Table 7).



BOX 15. STANDARD PRECAUTIONS

Standard precautions are the minimum standard (also described as the gold standard) for all patients at all times, irrespective of the diagnosis. They are based on a risk assessment and logical practices, as well as the appropriate use of PPE to protect health care providers from infection and prevent the spread of infection from patient to patient.

Standard precautions include:

- hand hygiene
- use of PPE
- prevention of needlestick or sharps' injuries
- adherence to respiratory hygiene/cough etiquette
- environmental cleaning
- handling of linen/laundry
- waste disposal
- appropriate patient placement
- health care worker safety.

The reader is reminded of the importance of understanding and conveying the message that contact precautions refer to an additional suite of interventions (addressed within this chapter) to be used in special circumstances that arise when a patient has confirmed or suspected colonization or infection with a CRO. Standard precautions for all patients is non-negotiable.

(Based on WHO and CDC definitions: https://www.who.int/csr/resources/publications/EPR_AM2_E7.pdf; <https://www.cdc.gov/infectioncontrol/basics/standard-precautions.html>.)

BOX 16. THE NEED FOR CLEAR DEFINITIONS – ISOLATION AND COHORTING

Inconsistency in the use of the terms 'isolation' and 'cohorting' is a risk to effective implementation. A common language of infection prevention and the avoidance of ambiguity can help effective communication of messages contained within guidelines (7). The following standard definitions are suggested.

Isolation

- Refers to the physical placement of patients
- Place patients in single-patient rooms when available, with dedicated equipment (preferably with own toilet facilities) and staff.
- Isolation could be considered to be a cohort of one person.
- When single-patient rooms are in short supply – cohort.

Cohorting



- Refers to the grouping of patients who are colonized or infected with the same resistant organism with the aim to confine their care to one area and prevent contact with other susceptible patients (for example, all patients infected or colonized with a CRE in a specific cohort, all patients colonized with MRSA in a different cohort).
- Cohorting is reserved for situations where there are insufficient single rooms or where the cohorting of patients colonized or infected with the same pathogen is a more efficient use of hospital rooms and resources.
- Dedicated equipment (including toilets) and staff should be used for patients within the cohorted area.

It is important to avoid cohorting patients with different resistant microorganisms (for example, CRE with CRPsA or CRAB). Ideally, the type of carbapenemase produced by the isolated microorganism should also be taken into consideration, that is, patients with different carbapenemase-producing (CP) organisms should be placed in separate cohorts. If this is not feasible, these patients should at least be geographically separated from each other within the cohorted area and one nurse should be dedicated to each cohort.

KEY CONSIDERATIONS, BARRIERS, SOLUTIONS AND IMPLEMENTATION EXAMPLES

Table 7 below should be read in conjunction with the explanations and details of the WHO multimodal improvement strategy provided in chapter 2. It provides a summary of actions to consider when implementing the recommendation on cleaning in a practical way. These are suggestions that might be effective in achieving sustainable improvement, but they require local decision-making according to the facility's needs and goals.

Table 7: Elements of the multimodal strategy – the 'how' of improvement

<p>SYSTEM CHANGE "BUILD IT"</p> 	<ul style="list-style-type: none"> • Put in place/improve a sustainable system to reliably procure and deliver necessary supplies needed to enable: (a) compliance with hand hygiene at the 'Five Moments', that is, alcohol-based handrub at the point of care, water, soap and hand drying materials; (b) compliance with recommended contact precautions, that is, PPE, with a focus on the need for a range of sizes. • In settings where water access/quality are not readily available, develop a plan for improving water access and quality. • In settings where bar soaps are used for handwashing, they should be kept dry; hand drying materials should be single use. • For special considerations relating to clinical handwash basins/sinks, including location and design, see the system change section in chapter 5 (environmental cleaning). • Develop/adapt enforceable protocols/standard operating protocols available at the point of care on: (a) who decides about patient isolation (that is, designate nurses as decision-makers on isolation as they are 24/7 on the wards and it can be done in a more timely manner; (b) which organisms require the implementation of contact precautions and isolation; (c) criteria for ward closure, for example, outbreaks; (d) when is it acceptable to care for patients with different CROs in the same cohort and how the geographical separation should be done (that is, where there is no availability of separate rooms and influenced by local epidemiology); (e) what supplies need to be procured and distributed regularly. • Define and agree on roles and responsibilities for effective procurement systems with strong IPC involvement. • In settings where single rooms are in short supply/unavailable, consider using coloured tape on the floor to reinforce contact precautions and the geographical separation of cohorted patients.
<p>TRAINING AND EDUCATION "TEACH IT"</p> 	<ul style="list-style-type: none"> • Assess local training needs. • Put in place/improve a reliable mechanism for producing/using updated training resources and information for staff on these recommendations with a focus on: (a) the use of risk assessment; (b) practical hands-on/real-life demonstrations (for example, PPE use); (c) training materials in the local language. • Reinforce application of the 'Five Moments' for hand hygiene for patients with invasive devices (see hand hygiene Tools and Resources). • Ensure that senior management and hospital administrators fully understand all aspects of CROs, including the importance of the moments for hand hygiene, the use of PPE, and the indications for contact precautions and isolation. • Secure sign-off of training plans by senior managers (for example, by the IPC committee or equivalent) • Train staff on a regular schedule on all aspects of these recommendations (focus on pre-employment/orientation and periodic updates) and enable staff to train others. • Develop information/educational resources using a range of media for patients and carers with a focus on the implications of infection/colonization and psychological support. • Those performing training should be competent in the subject matter.

**MONITORING AND
FEEDBACK
"CHECK IT"**



- Put in place/improve a monitoring, reporting and feedback mechanism (including roles and responsibilities) regarding:
 - ▷ reliable availability of hand hygiene infrastructures and products, for example, clinical handwash basins, soap, water, hand drying products, alcohol-based handrub;
 - ▷ percentage of staff compliant with standard operating procedures/protocols, for example, hand hygiene compliance according to the 'Five Moments'; (b) use of contact precautions, including a mechanism for reporting shortages, stock-outs and failure of PPE;
 - ▷ reliable availability of isolation and cohorting facilities;
 - ▷ appropriate use of isolation and cohorting facilities;
 - ▷ availability and use of patient and visitor information materials;
 - ▷ correct and timely implementation of contact precautions and isolation or cohort (that is, isolation of all patients with positive results for CRO in the last 24 hours).
- Ensure that monitoring, reporting and feedback mechanism address decision makers in addition to health care workers.
- Consider the development/use of daily/weekly checklists,

**COMMUNICATIONS
AND REMINDERS
"SELL IT"**



- In collaboration with staff, develop/adapt:
 - ▷ bedside identification reminders that respect the patient's rights to privacy and dignity;
 - ▷ awareness-raising messages (for example, posters) placed appropriately to remind staff of correct practices;
 - ▷ scripts/prompts for local champions to use when communicating on necessary IPC measures for CROs (for example, strict use of contact precautions);
 - ▷ memos (electronic/paper) to communicate rapidly and on a large scale, for example, during outbreaks;
 - ▷ videos on the appropriate use of PPE;
 - ▷ patient information materials (leaflets and visual resources to account for low literacy).
- Support and strengthen communications between different team members (laboratory, microbiology, IPC, clinicians).

**SAFETY CLIMATE
AND CULTURE CHANGE
"LIVE IT"**



- Encourage senior management to use relevant opportunities to explain that the facility is supportive of tackling AMR/ CROs and to promote and reinforce protocols/standard operating procedures.
- Engage senior clinicians and nurses to explain to colleagues the importance of hand hygiene, contact precautions and isolation/cohorting.
- Identify champions to be role models for the correct use of PPE.
- Put in place visible signage showing key leader commitment to hand hygiene and contact precautions.

A number of challenges/barriers may be faced that will impact on implementation success. Table 8 lists some of the common barriers to implementation that IPC practitioners have encountered, together with potential solutions. Implementation examples provided are focused (but not exclusively) on low-resource settings. The content elements are grouped according to the WHO multimodal improvement strategy.

Table 8. Potential barriers and solutions (contact precautions, including hand hygiene and isolation)

Potential barrier(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • Lack of financial support resulting in limited stocks/supplies of products (for example, alcohol-based handrub, PPE, such as gowns) and the potential reuse of PPE. • Lack of protocols resulting in poor clarity on PPE specification. • Lack of single-room availability. • High workload and lack of health care workers to care for patients in isolation. • Long-term patients housed in acute wards. 	<ul style="list-style-type: none"> • Present real-life case studies to hospital administrators and finance departments to build a strong case for investment, including architectural changes as a long-term solution (see Box 17). • Develop PPE specification documents in a simple format, for example, 1-page rapid advice documents, use of visuals/icons. • Develop standard operating procedures/ protocols to address: (a) use of dedicated patient equipment and dedicated nursing staff for cohorted patients when single rooms are unavailable; (b) how to prioritize the use of PPE according to risk assessment to prevent unnecessary use (for example, PPE use only when the health care worker touches patients); gown use reserved for more invasive encounters with likely exposure risk to body fluids; (c) the use of woven reusable gowns that can be sterilized after use, which has the potential to reduce costs and waste in LMICs; (d) reinforcement of messages not to reuse/reprocess medical gloves due to lack of standardized, validated and affordable procedure for safe glove reprocessing; (e) algorithms and risk prioritization matrices to help decision-making on when to isolate/cohort and when to stop. In some instances, consider where is the best place to care for a patient (see Box 17). 	<p>The value of prioritization</p> <p>“Limited resources are a huge problem for us. In many cases, we have patients paying for the PPE. However, if the patient is unable to pay, the cost needs to be borne by the hospital, and that is a challenge. So we do have cleaned and washed PPE (gowns only) and disposable face masks and gloves worn during the care of the patient, particularly those who are immunosuppressed. We do prioritize patients who need such PPE to be worn by staff. Clinical microbiologist and IPC consultant, India</p> <p>“During periods of supply shortages (specifically, gowns) and/or outbreaks, we prioritize hospital areas based on the probability of cross-transmission of CROs, according to risk assessment. By doing so, we extend the duration of PPE without putting patients at considerable risk. That is, we prioritize in the following order: intensive care units (adult, neonates); then semi-intensive care units; then regular wards.” Hospital epidemiologist, Panama</p> <p>The value of cohorting</p> <p>“In endemic settings, cohorting colonized or infected patients with the same CRO and assigning a nurse per shift to those patients may solve the problem of nursing staff shortage.” ID physician, Greece</p> <p>“In our resource limited setting we use cohorting because we have limited separate isolation rooms and no isolation wards. What we do is place patients with known infections at the corner of one of our large wards i.e. forming a geographic cohort, and meet the patients needs after other patients. One nursing staff is dedicated to the cohort patients and each nurse has their own patient kart for that cohort.” IPC practitioner, Egypt</p>

Table 8. Potential barriers and solutions (contact precautions, including hand hygiene and isolation), continued

Potential barrier(s)	Potential solution(s)	Implementation examples
		<p>"We in our hospital have problems with <i>Acinetobacter baumannii</i>. In our resource crunched setting, we do cohort patients colonized or infected with <i>Acinetobacter baumannii</i> calcoaceticus complex both on the floors and in the ICU. This happens due to the shortage of single occupancy rooms. A predicament faced is when bed linen, the upholstery, curtains, chair covers etc have had to be removed down, disinfected, washed and replaced with new sets for the next patient. This organism is unique in its ability to colonise inanimate and dry environs surrounding the patient. This compounds the problem as compared to CRE Enterobacterales." Clinical Microbiologist and Infection control consultant, India</p> <p>The value of patient flagging</p> <p>"All elective patients have to pass through a special ward and are risk assessed. Patients are screened once or twice a week. If positive, they are isolated. Positive patients are followed up by weekly screening as inpatients and after two months post-discharge. If negative at that time, they are followed up once again after 12 months. In terms of readmission, patients are labelled, but if there are two negative cultures in one year, then the label is removed." Clinical microbiologist and IPC lead, The Netherlands</p>

Table 8. Potential barriers and solutions (contact precautions, including hand hygiene and isolation), continued

Potential barrier(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • Lack of understanding, awareness and knowledge: (a) of the different terms used for CROs and IPC measures; (b) whether to use soap and water or alcohol-based handrub; (c) when to discontinue contact precautions/isolation; (d) when to use gloves. • Patients and caregivers frightened and anxious about isolation and the application of contact precautions. 	<ul style="list-style-type: none"> • Review all training material with a focus on: (a) international definitions; (b) the correct use and misuse of PPE; (c) the correct indications for glove use (see Tools and Resources); (d) the criteria for discontinuing isolation/contact precautions; (e) effective communication to reduce anxiety and meet the psychosocial needs of patients and carers. • Educate on the inappropriate use of PPEs (particularly glove use), purchase good quality disposable gloves and replenish stocks in a timely manner (see glove use information leaflet in Tools and Resources). 	<p>Targeted, tailored training</p> <p>“As a tertiary care facility and a teaching hospital, we have several health care worker categories and, similar to the colleague from Egypt, we tailored teaching materials according to their needs. Before 2015, when the institution didn’t have updated official prevention guidelines (environmental cleaning, medical device-associated infections, surgical site infection, etc.), the standardization of terms was a difficult task, with a perception of lack of confidence from health care workers.” Hospital epidemiologist, Panama</p> <p>“As a tertiary care facility in a limited resource country, we are facing many challenges regarding the training issues, compounded by understaffing, overcrowding and literacy obstacles among many of our patients, visitors and housekeepers. So we use a multifaceted approach to training on CROs. We tailor our training materials to address each group separately with a great attention to ensure that the training time does not disturb their routine schedule. For example, the training materials tailored for physicians are based on scientific facts and delivered in English. But those for nurses, housekeepers and patients are more simplified and presented in our mother tongue. The facts are greatly simplified and delivered in the form of storytelling and cartoon characters and colourful posters or simple videos. Training sessions are short, comprehensive and to the point as much as possible. We document training by distributing certificates or taking signatures on the training topics and schedule the training to be repeated during the entire week to cover those on night shifts, with an emphasis on on-the-job training sessions.” IPC practitioner, Egypt</p>

Table 8. Potential barriers and solutions (contact precautions, including hand hygiene and isolation), continued

Potential barrier(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • Lack of staff trained and competent in the monitoring aspects associated with hand hygiene compliance, contact precautions and isolation/cohorting. • Lack of dedicated time for monitoring and feedback activity. • Monitoring used in a punitive fashion, thus resulting in potential conflict between those undertaking the audits and those being audited. 	<ul style="list-style-type: none"> • Use the infection prevention and control assessment framework (IPCAF) results to highlight weaknesses in monitoring and feedback capability to senior managers / administrators to build a case for additional resources. • Refer to the sample action plan on the monitoring/audit of IPC practices (see Tools and Resources). • Explain to senior managers that monitoring/audit and feedback are key elements of multimodal improvement strategies and continuous quality improvement and should not be connected to punitive measures but rather take place as part of a culture of learning. • Make sure that senior managers do not use compliance monitoring data in a punitive way by providing clear explanations and interpretation of the data, including exploring whether poor compliance could depend on shortages of supplies (for example, antiseptic soap, disposable gowns, etc.). • Consider the use of facilitative/supportive supervision, including coaching and teaching. 	<p>The value of real-time responses</p> <p>“Our hospitals use checklists and the IPC team send a daily status report to the national level that addresses where patients are and the type of isolation. This happens 5 days a week. Such an approach enables real-time responses to emerging problems - if areas are less than compliant, a timely intervention is implemented.” ID physician, Israel</p> <p>“We undertake a once-weekly isolation round using a checklist based on several parameters - correct labelling, correct PPE, correct cleaning/ disinfection. A dashboard approach ensures feedback to all departments. This is quite useful and compliance is around 85-90%. However, this is labour-intensive and we are now using sensing technology (real time) where you don’t need humans, but this is a long-term project!” Clinical microbiologist and IPC lead, The Netherlands</p> <p>“Our checklists are scored and feedback is provided monthly to relevant committees for every department. The scores are used for improvement and not in a punitive way.” IPC practitioner, Egypt</p>

Table 8. Potential barriers and solutions (contact precautions, including hand hygiene and isolation), continued

Potential barrier(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • Lack of awareness of correct practices when caring for a patient with a CRO. • Lack of information provided to patients and carers on the need for special IPC precautions related to CROs, resulting in anxiety and stigmatization. • Low level of patient literacy hampering the use and usefulness of written information for patients and visitors, although available. 	<ul style="list-style-type: none"> • Ensure that the IPC team receives laboratory results at the same time as clinical teams to support timely information dissemination and alerting or checking with ward clinicians and nurses. • IPC team maintains a line list of CRO-positive patients including: current hospital location; microorganisms; date of identification; date of implementation of prevention measures; successive culture results; and date of cessation of isolation measures. Communicate this information to ward-level colleagues. • Use reminders and other flags to communicate status on admission and at the time when the patient is put in isolation/cohorted. • Use end of bed (for example, on patient chart)/door signage to reinforce contact precautions. • Work with patient bodies/associations when developing patient information materials to strengthen communication and information giving. • Routinely place CRO status in the discharge summary. • Ensure that all information developed explains the implications of CRO carriage/infection, including any expectations stipulated in local policies. For example, the patient and family should remain in the patient room, as well as implications on discharge, that is, resumption of normal behaviour. • Use non-written communications e.g. “smart screens” to play films, songs or cartoons to reach patients with low literacy. 	<p>Use a range of communication methods and approaches</p> <p>“We tried to introduce leaflets, but it didn’t work so well. Now we are developing videos to educate patients on resistant organisms.” Clinical microbiologist and IPC lead, The Netherlands</p> <p>“Using the patient association as a link for communication with patients brings an additional dimension for the information and sensitization of patients.” Clinical microbiologist and IPC lead, Senegal</p> <p>“We felt that a big challenge was not so much the language barrier. but rather communicating complex messages to very sick patients and their families. We took this into account when developing our information leaflets.” ID physician, Switzerland</p> <p>“We use checklists and standardized alert signs including pictograms. These are really important and used for training.” ID physician, Médecins Sans Frontières/Doctors Without Borders</p> <p>“We use electronic medical record alerts and posters on the room door or at the cubicle entrance.” Infectious disease physician, Singapore</p> <p>“We are struggling with the use of signage in patient units because of stigmatization. However, in most cases, this is solved by providing the right information at the right time.” Hospital epidemiologist, Panama</p> <p>“The report of the patient is clipped with an advisory for the IPC precautions to be used for the said patient. In addition, we phone the consultant (clinical) in charge of the patient and discuss possibilities for the implementation of IPC practices. This is also checked and discussed further on rounds. Signage on the doors of patients have posed problems as patients are illiterate and do not understand the difference between CRO isolation and tuberculosis/ HIV diagnosis.” Clinical Microbiologist and Infection control consultant India</p>

Table 8. Potential barriers and solutions (contact precautions, including hand hygiene and isolation), continued

Potential barrier(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • Lack of engagement in IPC by senior managers/leaders resulting in low support for a CRO-prevention culture results in poor enforcement of hand hygiene, contact precautions and isolation/cohorting. • Defective communication/relationships between IPC and hospital administrators/ managers. 	<ul style="list-style-type: none"> • Use the IPCAF to gather information to drive action by senior managers. • Emphasize health care worker accountability and the right of all patients to protection from avoidable harm. • Address all elements of the multimodal strategy. • Accreditation can be a driver towards ensuring that isolation and cohorting capacity is addressed. 	<p>Executive support drives culture change “The chief executive officer of each hospital must report a range of indicators to the national centre for disease prevention and control, including information not only on the incidence of bloodstream infection by CROs, but also on compliance with the ‘Five Moments’ for hand hygiene, contact precautions, consumption of antiseptic agents for hand hygiene, isolation or cohorting and our educational activities to promote IPC. This is powerful in creating a culture that takes CROs very seriously.” Infectious disease physician, Greece</p> <p>The value of accreditation “Seeking accreditation is the fuel for the top managers and all the working staff in our tertiary care hospitals to support all the aspects of infection control standards - we are mainly six major hospitals, three are accredited and the remaining are on their way.” IPC practitioner, Egypt</p>

BOX 17. CASE STUDY – ISOLATION AND COHORTING IN PRACTICE

“Isolation and cohorting is not always feasible in our country. However, during a hospital-wide CRE outbreak in 2011 (due to *Klebsiella pneumoniae* carbapenemases (KPC)-producing *K. pneumoniae*), a “transition ward” was established for non-critical patients. At hospital admission (either emergency or elective admission), all patients were assessed for recent hospitalization in high-risk health care facilities (defined as contact with any kind of health care facility from January 2011 at the beginning of the outbreak). If this was the case, a rectal swab (by chromo agar or polymerase chain reaction analysis, depending on availability) was performed and patients were immediately admitted to the transition ward where all patients were managed with contact precautions (trying to keep at least the recommendation of one metre between patient units and segregation of suspected/probable/confirmed patients). Upon a positive result, the patient was transferred to an “isolation ward” in which only positive patients (colonized or infected) were admitted and managed (in two-bed units) with dedicated personnel. Negative patients were transferred to a regular ward without contact precautions. Positive patients were maintained in the isolation ward until discharge and included in a database. In the case of readmission, positive patients were admitted directly to the isolation ward after checking the database (it wasn’t easily implemented). If more than six months had passed after the latest discharge, a new rectal swab was requested. These measures were implemented in a short period of time under an outbreak declaration. With the outbreak closed, the isolation ward serves at present to admit patients (colonized/infected) with KPC-only Enterobacteriaceae (E-KPC), *Clostridium difficile* and *Candida auris* (all managed by dedicated, cohorted personnel). Apart from the isolation ward, we have limited separate isolation rooms, so patients colonized or infected with CRE-CRAB-CRPsA (except for E-KPC) are admitted to their respective ward and managed with contact precautions (shared room without dedicated personnel).

At hospital admission (either emergency or elective admission), all patients are assessed for recent hospitalization in high-risk health care facilities (defined as contact with any kind of health care facility with an active outbreak or cases of E-KPC in the last six months). The special considerations that are still in place for E-KPC (specifically for KPC-KP) are (to some extent) a direct consequence of negative outcomes experienced by patients, their family and health care workers (increased morbidity and mortality, legal issues, etc.).

Dr Roderick Chen Camano, Caja Seguro Social Hospital, Panama

BOX 18. CASE STUDY - OVERCOMING CHALLENGES IN AN OUTBREAK CONTEXT**THE PROBLEM**

"We had three nosocomial infections caused by CRPsA identified in three consecutive days (identified by laboratory-based surveillance) in a surgical ward of 10 rooms with six beds each. At diagnosis, the patients were located in three different rooms sharing the same medical and nursing staff with other patients. The probability of cross-transmission was considered likely, so measures were escalated with the third case and an outbreak was declared."

THE APPROACH TAKEN

"The surgical ward was closed to new admissions and elective surgeries were put on hold. Three cohorts were created within the same ward: (1) infected cases; (2) contact cases pending surveillance culture results (axillar and inguinal swabs were taken from contacts with a focus on CRPsA); (3) No-contact cases waiting for discharge or transfer to a critical ward."

THE IMPACT

"Three colonized cases were identified without the development of any further infection. Measures lasted several days until cross-transmission was interrupted and the surgical ward was reopened without a complete shutdown."

BOX 19. CASE STUDY – ADDRESSING THE CHALLENGE OF LIMITED RESOURCES

"These recommendations could be considered extremely challenging in contexts with limited resources. In particular, their feasibility beyond tertiary care hospitals where there are limited resources, too few human resources, an absence of needed materials and limited or no laboratory capacity. What do we do in these settings? The hospitalization of patients carrying CP germs in these establishments would be a very favourable factor for the spread of these strains. For this reason, we should consider where it is best to care for these patients. It might in fact be best to prohibit the hospitalization of patients with CROs in hospitals or health centres or clinics without a programme for the management of these cases. It will of course require accompanying measures, such as technical guidelines, on how to deal with them because they will need to be managed, but the key is to consider the option of non-hospitalization, balancing this against the clinical needs and safety of the patient."

Professor Babacar Ndoye, IPC expert, Senegal

TOOLS AND RESOURCES

WHO and other agency supporting tools

General CRO-related tools and resources

- Australian Commission on Safety and Quality in Health Care. Recommendations for the control of carbapenemase-producing Enterobacteriaceae (CPE). A guide for acute care health facilities (<https://www.safetyandquality.gov.au/wp-content/uploads/2017/05/Recommendations-for-the-control-of-Carbapenemase-producing-Enterobacteriaceae.pdf>).
- US Centers for Disease Control and Prevention facility guidance for the control of carbapenem-resistant Enterobacteriaceae (CRE) - November 2015 Update - CRE toolkit (<https://www.cdc.gov/hai/pdfs/cre/CRE-guidance-508.pdf>).
- United States Agency for Healthcare Research and Quality (AHRQ) Carbapenem-resistant Enterobacteriaceae (CRE) control and prevention toolkit (2014) (<https://www.ahrq.gov/professionals/quality-patient-safety/patient-safety-resources/resources/cretoolkit/index.html>).
- Public Health England. Acute trust toolkit for the early detection, management and control of carbapenemase-producing Enterobacteriaceae (December 2013). London: Public Health England, United Kingdom (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/329227/Acute_trust_toolkit_for_the_early_detection.pdf).
* Currently undergoing revision, issue date anticipated is July 2019 for the consultation and testing phase.
- Public Health England. Toolkit for managing carbapenemase-producing Enterobacteriaceae in non-acute and community settings (2015). London: Public Health England, United Kingdom (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/439801/CPE-Non-AcuteToolkit_CORE.pdf).
*Currently undergoing revision, issue date anticipated is July 2019 for the consultation and testing phase.
- European Union/EEA guidance/guideline documents are available from Belgium, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Portugal, Poland, Slovakia, Slovenia, Spain, Sweden and the United Kingdom (<https://ecdc.europa.eu/en/publications-data/directory-guidance-prevention-and-control/prevention-and-control-infections-1>).

General IPC implementation resources

- WHO core component implementation resources (<http://www.who.int/infection-prevention/tools/core-components/en/>).
- WHO Interim practical manual supporting implementation of the WHO guidelines on core components of infection prevention and control programmes. Geneva: World Health Organization; 2018 (<http://www.who.int/infection-prevention/tools/core-components/facility-manual.pdf> in particular, see page 90: (a) sample action plan: monitoring/audit of IPC practices and feedback; see page 99: sample action plan: built environment, materials and equipment for IPC).
- WHO IPCAF (<http://www.who.int/infectionprevention/tools/core-components/en/>).
- CDC Infection control assessment tools (<https://www.cdc.gov/hai/prevent/infection-control-assessment-tools.html>).

Hand hygiene tools

- WHO hand hygiene tools and resources (general) (<http://www.who.int/infection-prevention/tools/hand-hygiene/en/>).
- WHO hand hygiene self-assessment framework (http://www.who.int/gpsc/country_work/hhsa_framework_October_2010.pdf?ua=1).
- WHO hand hygiene guide to implementation and associated resources (<http://www.who.int/infection-prevention/tools/hand-hygiene/en/>).
- WHO 'Your Five Moments' for hand hygiene poster (https://www.who.int/gpsc/5may/Your_5_Moments_For_Hand_Hygiene_Poster.pdf?ua=1).
- WHO 'How to handrub' and 'How to handwash' posters (https://www.who.int/infection-prevention/tools/hand-hygiene/workplace_reminders/en/).
- WHO tools as reminders in the workplace (including application of the 'Five Moments' and a patient with: (a) postoperative wound; (b) central venous catheter; (c) peripheral venous catheter; (d) endotracheal tube; and (e) urinary catheter), with the aim to emphasize specific strategies within healthcare facilities and the use of these tools at the bedside (<http://www.who.int/infection-prevention/tools/hand-hygiene/en/>).
- WHO glove use information leaflet (including the glove pyramid) (http://www.who.int/gpsc/5may/Glove_Use_Information_Leaflet.pdf).

WHO and other agency supporting tools

Contact precautions, isolation and cohorting-related tools

- CDC standard precautions for all patient care (<https://www.cdc.gov/infectioncontrol/basics/standard-precautions.html>).
- CDC transmission-based precautions (including contact precautions) (<https://www.cdc.gov/infectioncontrol/basics/transmission-based-precautions.html>).
- Society of Healthcare Epidemiology of America. Expert guidance duration of contact precautions for acute-care settings (<https://www.cambridge.org/core/journals/infection-control-and-hospital-epidemiology/article/duration-of-contact-precautions-for-acutecare-settings/94E38FDCE6E1823BD613ABE4E8CB5E56>).
- Society of Healthcare Epidemiology of America/CDC. Outbreak response training program. Defending against superbugs: an interactive case study managing an “outbreak” of carbapenem-resistant Enterobacteriaceae (CRE) in a hospital setting (<https://shea.med-ic.com/defending-against-superbugs-an-interactive-case-study-managing-an-outbreak-of-carbapenem-resistant-enterobacteriaceae-cre-in-a-hospital-setting.html>).
- NHS Scotland. Standard infection control precautions (<http://www.nipcm.hps.scot.nhs.uk/chapter-1-standard-infection-control-precautions-sicps/>).
- NHS Scotland. Transmission-based precautions (<http://www.nipcm.hps.scot.nhs.uk/chapter-2-transmission-based-precautions-tbps/>).
- NHS Scotland. Toolkit for managing carbapenemase-producing Enterobacteriaceae (CPE) in Scottish non-acute care settings. (see page 11: risk assessment flow chart: management of individuals positive for CPE (colonisation or infection); see page 15: guidance for undertaking a risk assessment on managing individuals positive for CPE (colonisation or infection) (<https://www.hps.scot.nhs.uk/resourcedocument.aspx?id=6220>).
- Public Health England. Carbapenemase-producing Enterobacteriaceae: early detection, management and control toolkit for acute trusts – risk prioritisation of infection prevention and control measures, screening and isolation (see page 10: who is responsible: front line employees in all units as part of admission process; see page 13 for information on negative screens) (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/329237/carbapenemase-producing_Enterobacteriaceae_Supplementary_Risk_Matrix_2014146.pdf).
- European Centre for Disease Prevention and Control (ECDC). Infection prevention and control measures and tools for the prevention of entry of carbapenem-resistant Enterobacteriaceae into healthcare settings: guidance from the European Centre for Disease Prevention and Control (2017).
- ECDC Technical Report. Risk assessment on the spread of carbapenemase-producing Enterobacteriaceae (CPE) through patient transfer between healthcare facilities, with special emphasis on cross-border transfer (https://www.ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/110913_Risk_assessment_resistant_CPE.pdf).

Patient and carer-focused tools

- Australian Commission on Safety and Quality in Health Care. Carbapenem-resistant Enterobacteriaceae (CRE): patient information sheet (<https://www.safetyandquality.gov.au/publications/cre-patient-information-sheet/>).
- NHS Scotland. Toolkit for managing carbapenemase-producing Enterobacteriaceae (CPE) in Scottish non-acute care settings (See pages 26, 29 and 32 for patient and family advice leaflets) (<https://www.hps.scot.nhs.uk/resourcedocument.aspx?id=6220>).
- Patient information leaflet, Geneva University Hospitals, Geneva, Switzerland (French) (<https://www.hug-ge.ch/sites/interhug/files/documents/enterobacterie.pdf>).

Use of tools to support implementation of hand hygiene, contact precautions, isolation and cohorting

Box 20 presents examples where tools have been used to support implementation of hand hygiene, contact precautions, isolation and cohorting in the context of CROs and summarizes (where applicable) some key lessons that might be useful for those considering using the tools to strengthen their approach to the prevention and control of CROs.

Current gaps in tool availability

There are a number of areas where the development of new tools is considered to be useful in supporting successful implementation. These tools could be developed at the international, national or local level and this manual aims to stimulate action to address these gaps. The following list highlights tools that have been identified for priority development.

- **Hand hygiene**
 - ▷ Apps to support integration of hand hygiene across all protocols/standard operating protocols.
- **Contact precautions**
 - ▷ Risk assessment tools
 - ▷ Algorithms for decision support
 - ▷ PPE quantity and costing calculator
 - ▷ Training videos, for example, on PPE use
 - ▷ Audit tool with scoring system to support stepwise improvement
 - ▷ Posters and signage to identify isolation areas

- **Isolation and cohorting**

- ▷ Algorithms for decision support
- ▷ Tool to assess infrastructure baseline requirements for isolation and cohorting
- ▷ Tools on when to discontinue isolation and under what conditions this should occur (may need to be part of an algorithm)
- ▷ Isolation index
- ▷ Cost-benefit tools, including costs to patients
- ▷ Superspreaders – how to identify them and the level of precautions to be taken.

REFERENCES

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2. Enterobatteri produttori di carbapenemasi. Bologna; Agenzia Sanitaria e Sociale Regionale - Regione Emilia-Romagna; 2017 (<http://assr.regione.emilia-romagna.it/ricerca-innovazione/prevenzione-antibioticoresistenza-infezioni/sorveglianza-controllo/controllo-rischio-infettivo/carbapenemasi>, accessed 8 February 2019).

BOX 20. EXAMPLES OF TOOL DEVELOPMENT AND USE

"In Israel, the ministry of health implements an annual incentives model, whereby hospitals are granted additional funding according to performance in IPC and AMR control. This performance is assessed and validated by the ministry, based on data submitted by the hospitals and site visits conducted by ministry IPC staff. All hospitals are notified in writing of their performance on each of model's elements, a press release is issued summarizing the results, and hospitals that excel are invited to an annual awards ceremony at the ministry."

ID physician, Israel

"We developed several tools to supplement the regional indications for CPE control – three information leaflets for patients/relatives and indications for the microbiologist: (a) for colonized patients and their relatives in hospital; (b) for colonized patients discharged at home; c) for colonized patients transferred to a long-term care facility; and (d) indications to the microbiologist on how to comment microbiology reports of CPE patients. The leaflets addressing patients and relatives were developed following discussion with focus groups involving patient representatives. All regional hospitals were requested to personalize them with the name and telephone number of the hospital/unit to allow patients to ask for further information. They have been widely used and have helped in communicating the risk to the patients." (2)

IPC physician, Agenzia Sanitaria e Sociale Regionale, Italy

CHAPTER 5 – ENVIRONMENTAL CLEANING

Cleaning is one of the most neglected activities in the health care facilities and toilets and sluice rooms are the most neglected areas.”

IPC lead, Cameroon

RECOMMENDATION 6: Compliance with environmental cleaning protocols of the immediate surrounding area (that is, the “patient zone”) of patients colonized or infected with CRE-CRAB, CRPsA should be ensured. (Strong recommendation)

RECOMMENDATION 7: Surveillance cultures of the environment for CRE-CRAB-CRPsA colonization/contamination (Conditional recommendation)

For many years, environmental contamination was considered to be less important than many other factors in contributing to HAIs and AMR spread. However, recent evidence shows that a contaminated health care environment (including items and equipment) plays a significant role in the transmission of microorganisms (1). This is why the built environment, materials and equipment for IPC are specifically addressed to highlight the importance of cleaning, disinfection and sterilization within the WHO guidelines on core components of IPC programmes at the national and acute health care facility level and other key WHO IPC guidelines and manuals (2, 3). Cleaning is a key horizontal intervention for the prevention of HAIs and is one of the standard precautions for achieving IPC. It is also important for the prevention and control of all multidrug-resistant organisms, including CROs. Box 21 summarizes the purpose of this chapter.

BOX 21. PURPOSE OF THE CHAPTER

- This chapter presents some essential implementation-related information on the elements of environmental cleaning and/or disinfection most relevant to the prevention and control of CROs, both in relation to isolated cases and outbreaks.
- It reinforces some central messages that apply to cleaning and/or disinfection in the context of the prevention and control of all HAIs.
- Where particular attention needs to be paid to cleaning and/or disinfection in the context of CROs, this is highlighted in the text, for example, where there is evidence to support enhanced cleaning practices for CRO prevention and control.
- The chapter also refers to surveillance cultures of the environment for CRE-CRAB-CRPsA as part of the methods to assess the efficacy of cleaning.
- The chapter is not intended to be a comprehensive manual on cleaning and/or disinfection and should be used in conjunction with other more specific resources on these topics.



PRACTICAL ASPECTS

THE WHAT, WHY, WHEN, WHO AND HOW

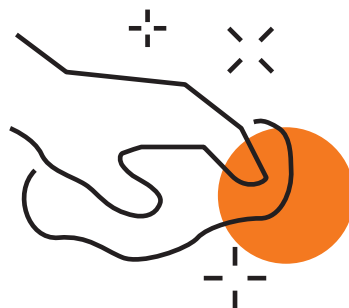
WHAT	<ul style="list-style-type: none"> • Routine daily cleaning according to local protocols should be guaranteed as a minimum for all patients in all situations, irrespective of CRO colonization or infection status. • In the case of a single patient colonized or infected with a CRO (confirmed or suspected). <ul style="list-style-type: none"> ▷ Perform enhanced cleaning of the patient zone. Enhanced cleaning involves an increase in the frequency of cleaning with a detergent (that is, more than once a day) and the use of disinfectants for high hand touch surfaces and high contamination risk surfaces (see Table 9 and Figure 1). ▷ The <i>thorough</i> cleaning of the patient zone(s) of patients colonized or infected with a CRO should be scheduled after cleaning other patient zones (that is, isolation areas should be cleaned after non-isolation areas). • During an outbreak of CROs. <ul style="list-style-type: none"> ▷ Strengthen enhanced cleaning schedules for the patient zone, including frequent assessment using auditing tools (see Table 6 and Figure 1). ▷ In some cases, ward closure (for example, restricting new admissions and/or transfers to/from the ward, and/or transferring all patients to another ward temporarily) is necessary to allow for the increased frequency and quality of cleaning (more than twice a day if there is an increased risk of environmental contamination with bodily fluids). ▷ Compliance with environmental cleaning protocols of the immediate surrounding area (that is, the 'patient zone'; see Box 22) of patients colonized or infected with CRE-CRAB-CRPsA should be measured and reported regularly (see Table 9). • The importance of the increased frequency of environmental cleaning in the prevention and control of CROs cannot be overstated. However, frequency can differ in different contexts and therefore the emphasis must be on risk assessment. The risk matrix in Annex 2 and the CRO illustration in Annex 3 provide useful information on cleaning and disinfection practices. • Cleaning solutions and equipment must be discarded/launched immediately after cleaning areas with suspected/confirmed CROs. • Environmental surveillance cultures may be considered as a key element of multimodal IPC interventions for CRE-CRAB-CRPsA control, in particular to monitor the efficacy of hospital cleaning.
WHY	<ul style="list-style-type: none"> • A clean and hygienic environment is considered to be one of the core components of effective IPC programmes. • Evidence also suggests that environmental cleaning contributes to a reduction in the bioburden of all multidrug-resistant organisms, including CROs, due to the known role of environmental contamination in facilitating the transmission of CROs.
WHEN	<ul style="list-style-type: none"> • See Table 9 (cleaning requirements, frequencies and products for environmental cleaning of the patient zone) and Annexes 2 and 3. • Surveillance cultures of the general environment are considered most relevant to CRAB outbreaks. Outbreaks of CRPsA colonization/infection among patients have been more commonly associated with environmental CRPsA contamination involving water and wastewater systems, such as sinks, taps (faucets) and shower drains.
WHO	<ul style="list-style-type: none"> • Hospital cleaning staff • Hospital managers (must be supportive of the importance of cleaning) • Nurse and/or physician in-charge/ward clinical staff • IPC lead and team • Any other staff responsible for cleaning • Microbiology laboratory staff (for environmental surveillance cultures).
HOW	<ul style="list-style-type: none"> • Use multimodal strategies (see Table 10).

BOX 22. THE PATIENT ZONE

The 'patient zone' concept refers to the patient's surroundings, irrespective of whether the patient is in a single room, a multiple-occupancy room or in a cohort. It includes all inanimate surfaces that are temporarily, but exclusively designated for that patient, as well as items touched by or in direct physical contact with the patient, such as the bed rails, bedside table, bed linen, infusion tubing, bedpans, urinals and other medical equipment. It also contains surfaces frequently touched by health care workers during patient care, such as keyboards, monitors, knobs and buttons and other 'high frequency' touch surfaces in the patient's immediate geographic area (see Figure 1). Patient body fluids generated within the patient zone (for example, faeces) should be transported by health care workers to the dirty utility area for disposal in a commode or bed pan for example, thus presenting a contamination risk. Therefore, dirty utility areas can be considered in this instance as an extension of the patient zone (see Figure 1) requiring special attention (see Table 9).

GENERAL PRINCIPLES

The aim of environmental cleaning is to minimize environmental contamination and support the achievement of a clean, safe and hygienic environment. Some of the general principles of cleaning are summarized in Box 23.



BOX 23. GENERAL PRINCIPLES OF ENVIRONMENTAL CLEANING AND DISINFECTION

- **Cleaning is an essential first step prior to any disinfection process to remove dirt, debris and other materials.**
- The use of a neutral detergent solution is essential for effective cleaning. It removes dirt and microorganisms while improving the quality of cleaning by preventing the build-up of biofilms and thus increasing the effectiveness of chemical disinfectants. This is particularly important in the context of CROs where biofilms are a problem.
- If disinfectants are indicated (see Table 9), they must be prepared and diluted according to the manufacturer's instructions. The use of recommended concentrations of disinfectant is important. Too high and/or too low concentrations reduce their effectiveness and high concentrations may damage surfaces.
- **Cleaning should always start from the least soiled (cleanest) to the most soiled areas (dirtiest) and from higher to lower levels** so that debris may fall on the floor and is cleaned last in a systematic manner to avoid missing any areas (for example, clockwise, left to right) (4).
- Environmental surveillance cultures may be a potentially useful measure to assess the level of contamination and the efficacy of cleaning in the surroundings of patients colonized or infected with CRE-CRAB-CRPsA, as part of a multimodal intervention.
- **Cleaning equipment:** it is essential that the chosen methods of cleaning produce minimal mists and aerosols or dispersion of dust in the patient-care areas.
- Bucket solutions become contaminated almost immediately during cleaning and the continued use of the solution transfers increasing numbers of microorganisms to each subsequent surface to be cleaned. Thus, detergent and/or disinfectant solutions must be discarded after each use in areas with suspected/confirmed CROs and it is essential that a fresh cleaning solution be made daily.
- Another source of contamination in the cleaning process is reusable equipment, such as the cleaning cloth or mop head, especially if left soaking in dirty cleaning solutions. It is essential that the detachable heads of used mops be machine laundered in a cycle that includes thermal disinfection and dried daily.
 - ▷ It is particularly important not to double-dip cloths into the bucket of detergent and/or disinfectant solution or leave cleaning cloths soaking (used for high-touch surfaces) in disinfectant solutions. They should be thoroughly saturated (wetted), used on all sides and disposed for reprocessing after use in each patient zone each time it is cleaned.
 - ▷ In general, best practice states that a clean/different cloth must be used for each patient zone (bed), which may be multiple times per day. This differs from a mop and cleaning solutions, which can generally be changed with lower frequency because they are only used for cleaning and not disinfection. It is recommended to frequently change cloths to prevent cross-contamination. In the context of CRO where the use of cohorting is employed, it is particularly important to ensure that the cloth is fully saturated with disinfectant so as to allow the correct contact time.
 - ▷ Mop buckets must be washed with detergent, rinsed, dried, and stored inverted to drain fully when not in use. They should be emptied and reprocessed in designated 'housekeeping' areas equipped with utility sinks (handwashing sinks should never be used for the disposal of solutions).
 - ▷ The detachable heads of used mops should be thermally disinfected in a laundry machine, if available. Soaking of mops in disinfectant solution is not recommended. After cleaning, keep mops in a dry condition when not in use. Equipment used for isolation areas (that is, CRO areas) should be colour-coded from that used for non-isolation areas.
 - ▷ A simplified approach to cleaning involves replacing soiled cloths and mop heads with clean items each time a bucket of detergent is emptied and replaced with fresh, clean solution. If a scrubbing machine is used, then the reservoir must be drained after use and stored dry.
- **It is essential that all cleaning equipment is kept in a good condition.**
- A designated area – for example, a room equipped with a utility sink – should be available for use by the hospital cleaning staff including for discarding water from mop buckets and should not be used to perform hand hygiene. Likewise, dedicated hand hygiene sinks should never be used for cleaning purposes or for disposal of any food waste.

In addition to environmental cleaning, timely and effective hand hygiene according to the WHO 'Five Moments' is a prerequisite for the prevention and control of CROs (see Chapter 4 on contact precautions). Based on evidence from guidelines, the patient zone (Table 9) of those known (or suspected) to be colonized or infected with a CRO requires special attention. This is the focus of the remainder of this chapter. Hospital cleaning staff should wear PPE to protect them from chemical and biological hazards (chemical spills and fumes) as well as (but not limited to) reusable heavy-duty latex gloves, mask and goggles, and perform hand hygiene at the right moments, including after glove removal. Training on the use of PPE and hand hygiene for this important group of workers is key (see Box 24).

BOX 24. HAND HYGIENE AND GLOVE USE FOR HOSPITAL CLEANING STAFF

Hand hygiene at the right times is essential for all health care workers as addressed in Chapter 4. In addition, hospital cleaning staff and other non-clinical health care workers must perform hand hygiene before starting work and after completing each task.

Non-disposable domestic gloves covering up to the mid-arm should be provided to ensure safety from exposure to chemical and accidental needlestick injuries. In some countries, these gloves are colour-coded, depending upon the area of use. In countries where this system does not exist, the same pair of gloves may be worn for the duration of the cleaning session, but they must be washed and dried at the end of the session. Any tears, leaks or damage will require a change of gloves and a fresh pair should be provided. All PPE required for cleaning (for example, gloves, aprons) should be put on before entering a given isolation area (after hand hygiene is performed) and removed (for disposal or reprocessing, if reusable) prior to departing that isolation area (followed by hand hygiene).

TERMINOLOGY, DEFINITIONS, FREQUENCIES AND PRODUCTS

A glossary of key terms and definitions is provided at the beginning of this manual. The three questions listed below are designed to support the reader in achieving the guideline recommendation, that is, effective cleaning of the patient zone of patients colonized or infected with CROs. Take a moment to consider these questions.

Topic area	Question
Definitions	Are you familiar with the frequently used terms and definitions?
Frequency	Do you know how often the patient zone and other relevant areas, items and surfaces should be cleaned and/or disinfected?
Products	Do you know what products should be used and those not to be used?

Table 9 summarizes information on the key terms, definitions, cleaning requirements/frequency and products. It is based on expert consensus and informed by a review of several national/organizational guidance documents on environmental cleaning and disinfection. It is important to note that the type and availability of products will vary across different contexts. The products listed in the table are provided as a guide only, based on expert consensus. Available resources will influence local decisions on product use.

Table 9 should be used in conjunction with the risk stratification matrix presented in Annex 2 and the illustrative example in Annex 3 to support decision-making related to the frequency and level of cleaning and/or disinfection. Annex 4 presents an overview of cleaning/disinfection products.

One of the most important aims of cleaning in the context of CROs is the prevention of biofilm formation. Keeping relevant surfaces clean and dry will help to achieve this aim. Special attention must be paid to handwash basins in clinical areas with the aim to keep these clean and dry (see Boxes 25 and 26).

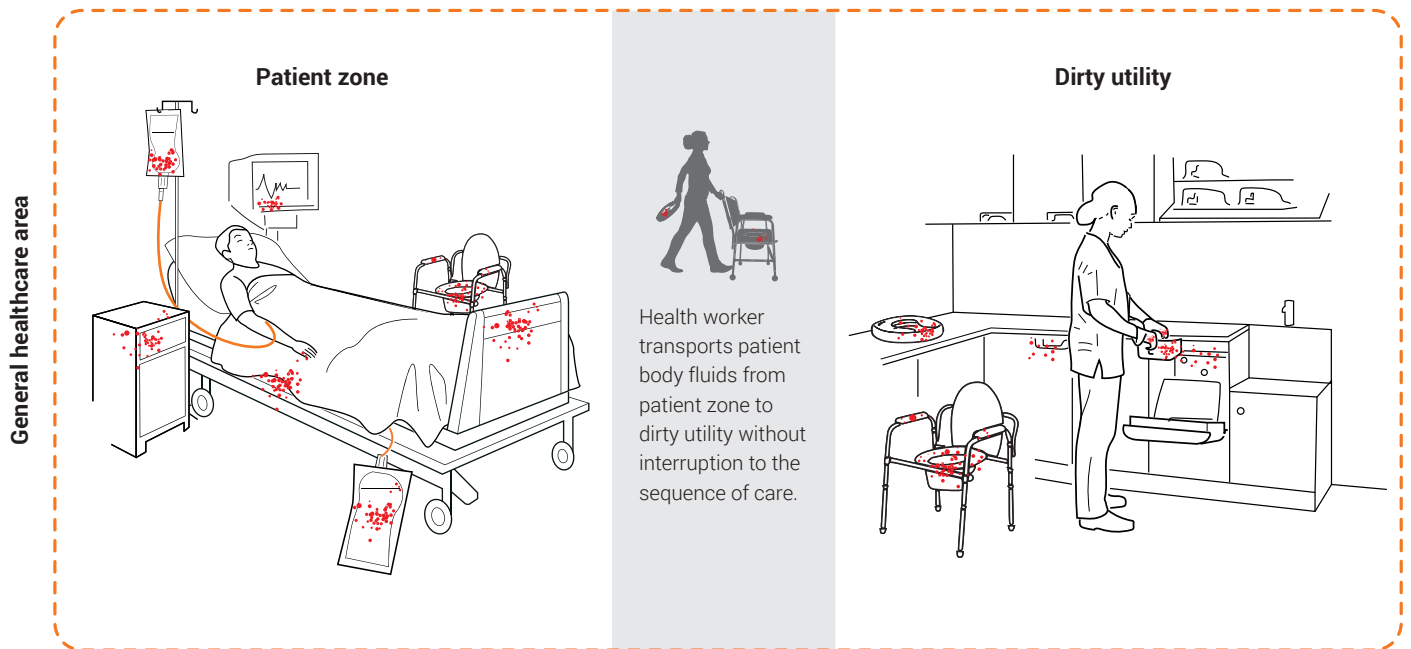
Table 9. Cleaning requirements, frequencies and products for environmental cleaning of the patient zone

Types of cleaning			
Term	Definition	Cleaning and/or disinfection requirement and frequency	Product(s) ¹
Enhanced cleaning (sometimes referred to as 'in-depth' cleaning)	Cleaning employed when there is a patient colonized or infected with a CRO (confirmed or suspected) in particular during an outbreak of CROs (or at the request of the IPC team).	<ul style="list-style-type: none"> • Requirement: thorough cleaning with detergent followed by drying, followed by disinfection of high frequency hand touch surfaces and high contamination risk surfaces within the zone (this extends to the sluice/dirty utility room, toilets, bathrooms and any area likely to be contaminated with a patient's faecal organisms, including CROs – see Figure 1). • Refer to the risk stratification matrix (Annex 2) and illustrative example (Annex 3). • Frequency: increased frequency, that is, more than once a day. • If there is an increased risk of environmental contamination due to shedding via blood and body fluids to be dealt with immediately, the frequency will be further increased and ward closure may occur (for example, restricting new admissions and/or transfers to/from the ward and/or transferring all patients to another ward temporarily). Refer to the risk stratification matrix. • The patient zone(s) should be thoroughly cleaned after other patient care areas (that is, isolation areas should be cleaned after non-isolation areas). 	<ul style="list-style-type: none"> • Neutral detergent, followed by a freshly prepared disinfectant solution of hypochlorite (1000 ppm) or alcohol wipe (60-80%), • for example, isopropyl, ethyl alcohol. • Do not use peracetic acid (not considered safe for routine environmental cleaning). • Blood/body fluid spills should be managed as per local protocols. There is no difference in cleaning/disinfection requirements for blood/body fluid spills in CRO carrier rooms versus non-carrier rooms: clean with neutral detergent to remove organic material, followed by the application of a 5000 ppm chlorine solution.
In-depth cleaning (term sometimes used instead of 'enhanced' cleaning)	See enhanced cleaning.	• See enhanced cleaning.	• See enhanced cleaning.
Standard cleaning (term sometimes used instead of 'routine' cleaning)	See routine cleaning.	• See routine cleaning.	• See routine cleaning.

Table 9. Cleaning requirements, frequencies and products for environmental cleaning of the patient zone, continued

Types of cleaning			
Term	Definition	Cleaning and/or disinfection requirement and frequency	Product(s) ¹
Routine cleaning (term sometimes used instead of 'standard' cleaning)	Cleaning employed <i>routinely</i> to prevent the transmission of microorganisms that may cause HAIs.	<ul style="list-style-type: none"> • Requirement: routine cleaning normally involves the use of neutral detergent with disinfectant use for high frequency hand touch surfaces – this may differ in different countries – follow local definitions. • Frequency: usually once a day or immediately when soiling or spills of blood/body fluid. 	<ul style="list-style-type: none"> • Neutral detergent. • For high frequency hand touch surfaces, use neutral detergent followed by a freshly prepared disinfectant solution of hypochlorite (1000 ppm) or alcohol wipe (60-80%), for example, isopropyl, ethyl alcohol.
Terminal cleaning (term sometimes used instead of 'discharge/transfer' cleaning)	Cleaning of the patient zone, undertaken following the discharge/transfer of any patient.	<ul style="list-style-type: none"> • Requirement: in addition to routine cleaning, includes cleaning of some low frequency hand touch surfaces (emphasis on horizontal surfaces) and high frequency hand touch surfaces that are not accessible when the room is occupied (for example, the patient mattress). Also involves the removal of bed linen, disposable patient items and reprocessing (cleaning and disinfection) of any dedicated patient care equipment. • Frequency: upon discharge/transfer of a patient or periodically (monthly) for long-stay patients. 	<ul style="list-style-type: none"> • Neutral detergent. • For high frequency hand touch surfaces use, followed by a freshly prepared disinfectant solution of hypochlorite (1000 ppm) or alcohol wipe (60-80%), for example, isopropyl, ethyl alcohol. • For blood/body fluid spills, clean with neutral detergent to remove organic material, followed by the application of a 5000 ppm chlorine solution.
Transfer/discharge cleaning (term sometimes used instead of 'terminal' cleaning)	See terminal cleaning.	<ul style="list-style-type: none"> • See terminal cleaning. 	<ul style="list-style-type: none"> • See terminal cleaning.

Figure 1: visualizing high frequency hand touch surfaces/surfaces potentially contaminated with blood and body fluids within the context of the patient zone



- High frequency hand touch surfaces and surfaces potentially contaminated with blood and body fluids.

Figure 1 highlights the high frequency hand touch surfaces within the patient zone that require special cleaning in the context of a patient colonized or infected with CROs as described in Table 9. It also illustrates the surfaces of potential highest contamination within a dirty utility room. Any area outside of the patient zone that is likely to be contaminated with the body fluids (particularly faecal contamination) of a patient colonized or infected with a CRO (for example, dirty utility) should be subject to enhanced cleaning as detailed in Table 9.

BOX 25. A DRY ENVIRONMENT PREVENTS THE SPREAD OF CRO

- Removal of biofilms through routine cleaning with a focus on high frequency hand touch surfaces will reduce much of the risk of CRO transmission.
- Enhanced cleaning described in Table 9 aims to reduce the level of soiling in the patient zone, which will help to stop biofilms forming as easily.
- Areas where faecal contamination is highest, such as sluices and toilets (high contamination risk surfaces), must be cleaned regularly and kept dry as far as possible to prevent biofilm formation.
- The bottom line – the removal of biofilms (wherever they may be) through thorough cleaning and drying of surfaces will help to stop CROs from spreading and causing harm.

BOX 26. SPECIAL FOCUS ON CLINICAL HANDWASH BASINS**Clinical handwash basins have been implicated in numerous outbreaks of CROs.**

- Health care providers should have policies in place to ensure that clinical **handwash basins are not used for other purposes**. For example, they must not be used for the disposal of any amount of liquid waste or the soaking/cleaning of any items and equipment.
- The following should be adhered to when handwash basins are installed.
 - ▷ **Size** - the dimension of the handwash basin should be large enough to contain most splashes during handwashing procedures.
 - ▷ **Hand hygiene products** - handwash basins should be fitted ideally with liquid soap dispensers and good quality paper towels. When liquid soap is unavailable and bar soap is used, small bars of soap in racks that facilitate drainage should be used to allow the bars to dry.
 - ▷ **Installation** – handwash basins should be wall mounted using concealed brackets and fixings that should also be sealed to a waterproof splashback to allow effective cleaning of all surfaces. The surrounding area should be made of non-porous material to resist fungal growth.
 - ▷ **Taps/faucets**
 - Taps should be fitted with a hands-free control (for example, elbow-operated) to avoid contamination. If a handwash basin with conventional tap handles is used, the water should be turned off using a paper towel rather than bare fingers or hands to avoid recontamination of hands.
 - Taps should not be aligned to run directly into the drain aperture as contamination from the waste outlet could be mobilized and generate aerosols responsible for cross-infection, especially with Gram-negative bacteria (*Pseudomonas* spp., multidrug-resistant Enterobacteriaceae, etc.) that colonize ‘U bends’, and then dispersed by splashing if disturbed by a stream of water.
 - Swan-neck tap outlets are not recommended as they do not empty after use. Similarly, strainers, aerators and flow restrictors should not be used as they become colonized with bacteria.
 - ▷ **Plugs** – handwash basins should not have a plug or a recess capable of taking a plug as hands must be washed in running water. Provision of a plug allows the basin to be used to soak and clean items and equipment and this must not be done.
 - ▷ **Overflow** – handwash basins should not have an overflow as this is not amenable to cleaning.
 - ▷ **Location** – alcohol-based handrub at the point of care (that is, within the patient zone) is the gold standard for routine hand hygiene. Ideally, clinical hand washbasins should not be located within the patient zone. Do not locate hand basins where a patient may get splashed when the handwash basin is used. They should also be readily available and accessible when needed, for example, not behind curtains.

Cleaning methods NOT recommended

1. Fumigation or fogging with formaldehyde must never be used. Use of other ‘no touch’ methods of room decontamination may sometimes be employed. The most commonly used method is the use of hydrogen peroxide. It must be emphasized that these approaches cannot replace routine daily cleaning because organic soil, liquids, waste and litter must be removed from the environment before the commencement of disinfection processes. Other disadvantages of machines using these technologies are that they can only be used in an empty room

- because the products are too toxic for patients (hydrogen peroxide). They are also expensive and require trained operators. If they are used, then only a validated system should be used for terminal disinfection of a room following discharge of patients on isolation precautions and after terminal cleaning, as recommended previously.
2. Use of spray bottles for dispensing detergent or disinfectant solutions within the patient zone is not recommended (due to aerosol generation).

Water availability and cleaning



Cleaning is influenced by the availability and quality of water within a health

care facility. In LMICs, many health care facilities have contaminated water sources. Water used for cleaning floors and surfaces need not be of drinking-water quality as long as it is used with a detergent and/or disinfectant. However, if water is used to make disinfectant solutions, it must be of low turbidity (ideally less than 1 nephelometric turbidity unit) and organic content and from an improved water source (5). After making the solution, the chlorine should be measured to ensure that the intended concentration has been achieved. Test strips to check the total chlorine concentration are available.

KEY CONSIDERATIONS, BARRIERS, SOLUTIONS AND IMPLEMENTATION EXAMPLES

Tables 10 and 11 below should be read in conjunction with the explanations and details of the WHO multimodal improvement strategy provided in Chapter 2. It provides a summary of actions to consider when implementing the recommendations on cleaning in a practical way. These are suggestions that might be effective in achieving sustainable improvement, but they require local decision-making according to facility needs and goals.

Table 10. Elements of the multimodal strategy – the “how” of improvement

<p>SYSTEM CHANGE “BUILD IT”</p> 	<ul style="list-style-type: none"> • Put in place/improve a sustainable system to reliably procure and deliver appropriate materials (detergents, disinfectants, mops, buckets, etc.) to ensure availability and accessibility at all times that they are required – see Table 9 and IPCAF (Tools and Resources section at the end of this chapter). • Define and agree on roles and responsibilities for all aspects of cleaning and/or disinfection, including the availability and placement of supplies/products, numbers of people available to undertake cleaning as detailed in Table 9 (numbers of hospital cleaning staff per bed is an issue that will be influenced by many factors, for example, bed occupancy rates, patient turnover, type of cleaning required). Special attention is required when defining roles and responsibilities for the cleaning of equipment such as pumps and monitors - usually hospital cleaning staff are not comfortable doing this and nurses sometimes do not see it as their role. • Develop a plan for improving water access and quality (that is, from an improved water source) in settings where not readily available to enable decontamination and cleaning to be undertaken according to the frequency described in Table 9. WHO recommends that 40-60 litres of water are required per patient per day for inpatients. • Put in place/improve a sustainable system to ensure that wastewater services are available for disposing of used cleaning solutions safely (that is, access to sewer systems or good on-site septic tanks to prevent environmental contamination). • Check whether facility/furniture design supports cleaning to be performed according to Table 9, that is, materials compatible with cleaning agents. • Ensure the availability of rooms for cleaning/disinfection purposes and storage of cleaning materials. • Develop/adapt a protocol/SOPs with instructions on cleaning and/or disinfection (including the safe handling of products) and temporary ward closure (as a last resort in some outbreak situations) – hospitals must be able to close wards to allow for enhanced cleaning. Protocols/SOPs should be based on national and international guidelines (see Box 27 for a list of suggested requirements when developing a SOP). • Keep protocols/SOPs simple; indicate a minimum number of different types of disinfectants and products. Many different products with different dilution protocols increase the chance of misunderstanding and errors during the process. • Develop/adapt standards for outsourced service providers.
<p>TRAINING AND EDUCATION “TEACH IT”</p> 	<ul style="list-style-type: none"> • Put in place/improve a reliable mechanism for producing/using training resources and information for staff on cleaning and/or embed information in existing training opportunities. Focus on the following issues. <ul style="list-style-type: none"> ▷ CROs – targeted at all hospital cleaning staff and all staff involved in cleaning. In some countries, cleaning of some medical items is undertaken by nurses and other trained persons and not solely hospital cleaning staff. ▷ Cleaning of high contamination risk surfaces (particularly sinks and toilets) and high frequency hand touch surfaces. • Develop/improve training materials consistent with SOPs.

<p>MONITORING AND FEEDBACK “CHECK IT”</p> 	<ul style="list-style-type: none"> • Put in place/improve a mechanism for: <ul style="list-style-type: none"> ▸ monitoring, reporting and feedback (including roles and responsibilities) regarding supervision of the work of hospital cleaning staff (usually a senior member of the hospital cleaning team, but may be the nurse in-charge, IPC focal point, and/or health care facility management); ▸ ensuring IPC committees are involved in reviewing hospital cleaning contracts, protocols and procedures; ▸ addressing structure, process and outcome indicators according to local protocols/SOPs (see Boxes 26 and 27). • Consider the feasibility of environmental surveillance, in particular linked to environmental cleaning. When a decision is taken to prioritize this, ensure the necessary human resources, microbiological/laboratory support, information technology, data management systems and a timely feedback mechanism. • Ensure IPC is considered when drafting external cleaning contracts/agreements – focus particularly on getting monitoring right – both routine and outbreak-related. A systematic approach to monitoring is important, with results used to drive improvement in processes. Timely feedback should be provided (do not focus only on visual monitoring!). • Patient feedback is valuable and should be considered as part of monitoring and feedback efforts.
<p>COMMUNICATIONS AND REMINDERS “SELL IT”</p> 	<ul style="list-style-type: none"> • In collaboration with staff, develop/adapt: <ul style="list-style-type: none"> ▸ awareness-raising messages (for example, posters) placed appropriately to remind staff of correct cleaning procedures/SOPs/protocols (for example, checklists, visual information/posters/flyers, dashboards); ▸ electronic and non-electronic flagging systems to remind/identify patients with CROs. • Support and strengthen communications between different team members through the development and use of clear and unambiguous terminology (see Table 9).
<p>SAFETY CLIMATE AND CULTURE CHANGE “LIVE IT”</p> 	<ul style="list-style-type: none"> • Promote the importance of a facility culture that supports hospital cleaning staff. • Secure leadership involvement and visible support for environmental cleaning, for example, convince management to provide a budget for the purchase of cleaning materials. • Work towards a holistic approach, such as a ‘total cleaning approach’ that is multimodal and multi-professional and fosters good collaboration between nursing staff and hospital cleaning staff. • Establish effective communication channels between nursing staff and hospital cleaning staff - inform the cleaning staff when patients are discharged; give cleaning staff the time and space to do their work. • Promote the value of the work of hospital cleaning staff as an important consideration in building a positive safety climate. • Explore the use of innovative ways and incentives to ensure cleaning takes place and drive improvement. • Establish mechanisms to ensure IPC team plays a role in motivating, supervising and valuing the work of hospital cleaning staff – lead by example and champion the cleaning staff. • Consider how to break professional barriers. IPC teams can lead in this area – consider the feasibility of including hospital cleaning staff as part of the wider IPC team, including those provided by external contractors. • Involve and engage patients and local communities in all aspects of hospital cleanliness.

A number of challenges/barriers may be faced that will impact on implementation success. Table 11 lists some of the common barriers to implementation that IPC practitioners and cleaning staff have encountered, together with some potential solutions. Implementation examples provided are focused (not exclusively) on low-resource settings. The table content elements are grouped according to the WHO multimodal improvement strategy.

Table 11. Potential barriers and solutions linked to environmental cleaning

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> Sourcing of equipment/materials (for example, difficulties obtaining neutral detergent, washable equipment). Quality of cleaning products, for example, inconsistent quality or strength of locally available chlorine-based products (bleach). 	<ul style="list-style-type: none"> Liaise with the national ministry of health to explore nationwide accessibility and quality control mechanisms of such products. Use test strips to ensure the appropriate strength/concentration of chlorine dilutions. National authorities or local groups of IPC professionals and bodies representing cleaning staff can have a 'data repository' for the technical specification of disinfectants and cleaning material, including test strips for different chemicals. 	<p>Dedicated multidisciplinary support for cleaning</p> <p>"We set up a procurement multidisciplinary team that meets regularly to review products and ensure the highest quality." IPC lead, English National Health Service</p> <p>High-level focus on efficacy</p> <p>"Disinfectant products in our hospital were based on microbiological efficacy, material compatibility, staff and patient safety considerations, cost and availability on the local market. Evidence-based guidelines or recommendations from authoritative sources (WHO, CDC) were reviewed to identify suitable disinfectants." IPC lead, Cancer hospital, India</p>
<ul style="list-style-type: none"> Availability of hospital cleaning staff to meet the demand. This can be compounded when hospital cleaning staff are asked to perform other duties (multi-tasking). In addition, many cleaning staff are not well paid, leading to high attrition rates. 	<ul style="list-style-type: none"> At least one person assigned for cleaning duties in each health care facility. National cleaning standards/guidelines can be useful in identifying and articulating satisfactory levels per specialty. Important to note the variables that influence satisfactory levels, for example, number of admissions/day, patient turnover, type of patients and likely volume of body fluids produced, vulnerability of patients, type of care, patient flow, presence of single rooms versus one large ward, general infrastructure and quality of a building (for example, more difficult to clean areas will require special attention). Consider rapid response teams/dedicated hospital cleaning staff and dedicated equipment for the patient zone of patients with CROs to meet the needs of enhanced cleaning. Consider financial or other incentives for performance. 	<p>Setting clear locally-based staffing levels</p> <p>"We have three cleaning shifts of hospital cleaning staff. One clean is done on every shift for all patient zones having a patient with CRO or for critical areas, such as intensive care units, irrespective of CRO patient status. Otherwise, all the hospital is cleaned two times a day as standard. We dedicate one person for toilet cleaning." IPC lead, Cancer hospital, India</p> <p>"In our general ward, we have a ratio of 12 beds per hospital cleaning staff. In our private and critical care units, it is 10 beds per cleaning staff and in the bone marrow transplant unit, 4 staff for 6 beds." IPC lead, Cancer hospital, India</p> <p>"We have planned for a dedicated patient transport team to free the hospital cleaning staff to focus on their important cleaning duties." IPC lead, Cancer hospital, India</p>

Table 11. Potential barriers and solutions (environmental cleaning), continued

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> • General infrastructure challenges, for example: <ul style="list-style-type: none"> ▷ costs associated with addressing handwash basin requirements; ▷ irregular water supply to support cleaning; ▷ limited access to sinks/dirty utility rooms for hospital cleaning staff (human factors); ▷ lack of piped wastewater systems, for example, connected utility sinks to septic systems). 	<ul style="list-style-type: none"> • Clean, covered water storage containers with taps (for example, a Veronica Bucket) can be placed in key areas with clear responsibilities of who should regularly fill the containers. • Longer-term efforts should aim to install water pipes, which may come from an on-site improved water source (borehole with elevated storage, rainwater tank) or municipal piped supplies. • Splashless sinks, special taps and special drains procured to design out the risks of splashing and biofilm formation. • Consider rain water harvesting (6) • Longer-term efforts to install wastewater pipes to an on-site septic system or a municipal system. 	<p>Risk assessment</p> <p>"We risk assess the environment including sink location, design and the presence of clutter for potential reservoirs. In particular, we look at sink cleaning regimes if there are a cluster of cases or if the sink is already in a high-risk area, then water testing is undertaken. For all confirmed positive cases, we recommend dedicated equipment allocated to the patient where possible, for example, blood pressure machines, etc. and minimal clutter in the isolation room to minimize cleaning needs and waste. We aim for isolation rooms to have en suite facilities to avoid the need for commodes or patient movement outside the room." Cleaning leads, English National Health Service</p> <p>Focus on sewage treatment</p> <p>"We have a sewage treatment plant at our hospital site for processing hospital sewage. An effluent treatment plant has been put in place for the hospital laundry to take care of the waste water." IPC lead, Cancer hospital, India</p>
<ul style="list-style-type: none"> • Lack of proficiency of housekeeping staff in English or other international languages (most guidelines are written in English or other international languages). 	<ul style="list-style-type: none"> • Develop housekeeping SOPs and guidelines in the local language/language in which hospital cleaning staff are proficient. 	<p>Use local languages and limit written instructions</p> <p>"For training housekeeping staff, we impart training in local languages (Bengali and Hindi). We have also used pictorial charts and examples of actual cleaning agents, disinfectants and cleaning equipment to make training more understandable." IPC lead, Cancer hospital, India</p>
<ul style="list-style-type: none"> • Terminal cleaning not possible, for example, due to the presence of long-stay patients, high bed occupancy, overcrowding and limited resources. 	<ul style="list-style-type: none"> • Consider buffer facilities to accommodate patients as a contingency in the case of outbreaks, renovation, new building work. • Consider long-term patients' room/bed transfer to allow proper cleaning during less busy periods. 	<p>Maximize all other prevention strategies</p> <p>"We have never been able to close wards for IPC requirements due to the high demand for beds and limited availability of inpatient beds. In places with a high endemicity of CROs, transmission has been kept under control using the principles of operations management, which have included the use of a cleaning checklist, cleaning SOPs, optimizing staff for cleaning based on the complexity of the cleaning task, and the involvement of cleaning supervisors to reduce the time needed for optimal cleaning." IPC lead, Cancer hospital, India</p>

Table 11. Potential barriers and solutions (environmental cleaning), continued

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> No training programme in place or training programme in place, but limited supporting materials available. 	<ul style="list-style-type: none"> Training programme/training curricula developed based on best practice guidance (either stand-alone or within existing curricula) and provided to hospital cleaning staff on induction and at periodic intervals in the local language/language in which hospital cleaning staff are proficient (focus on the risk assessment matrix (Annex 2) and illustrative example (Annex 3). Consider introducing certification to motivate and bring authority/status to the role. Put in place mechanisms to ensure all external contractors are trained by the IPC team on standards/ checklists as part of the contract. Build training requirements into the contract. 	<p>Guidelines supporting training</p> <p>“We use IPC technical guidelines to train all hospital cleaning staff on environmental cleaning and hold quarterly refresher meetings for all hospital cleaning staff.” IPC lead, district hospital, Ghana</p> <p>Participatory approaches</p> <p>“We involve cleaning staff, supervisors and managers in the development of training materials so they are fit for purpose and useful in delivering the learning outcomes.” IPC lead, English National Health Service</p> <p>Multifaceted training programmes</p> <p>“Housekeeping staff are regularly provided with training on biomedical waste segregation and handling, use of PPE, hand hygiene, importance of the material safety data sheet, protocol of spill management, list of disinfectants and their applications and optimal dilutions, besides SOPs on cleaning.” IPC lead, Cancer hospital, India</p>
<ul style="list-style-type: none"> Lack of clarity amongst staff on: definitions and terminology including which products to use when, for example: (a) confusion that a detergent and disinfectant are the same thing, resulting in the inappropriate use of bleach; (b) perception that floors are a risk for the spread of CROs and that disinfectants should be regularly used to clean them, thus leading to the overuse/inappropriate use of disinfectants. This confusion can be compounded by conflicting advice provided by external agencies/partners that is not evidence based and contrary to guideline recommendations. 	<ul style="list-style-type: none"> Refer to international (and where available national) guidelines and SOPs when developing training programmes. Use existing international training materials (see Tools and Resources). Use standardized terminology (see Table 6 and the glossary of key terms for examples) to foster a common understanding of cleaning requirements. Emphasize the importance of keeping floors clean and dry and focus the efforts of hospital cleaning staff on the patient zone and high frequency touch surfaces (Table 9 and Annex 2). In overcrowded wards where patients and family members may lie on the floor, provide clear explanations and discuss with the facility senior managers that disinfecting the floors is not a solution and the problem of overcrowding and bed occupancy should be tackled according to the WHO core component recommendation 7. Train staff on the importance of monitoring and feedback and the use of tools such as checklists to support this. 	<p>Addressing dirty floors</p> <p>“To address instances when the floor is dirty, wet or contaminated, we promote setting up a cleaning programme, which allows a dry clean surface, rather than using an ineffective programme of using a disinfectant to deal with dirt. Disinfectants are not designed to be detergents and so we advocate for a cleaning, rather than a disinfection programme, to manage floors where contamination is high.” Training lead, Infection Control Africa Network</p> <p>The value of manuals and standard operating procedures to guide training</p> <p>“We have very clear cleaning policies and a step-by-step manual. We mop floors, clean all surfaces, clean, check and turn mattresses, clean toilet and sink, remove and change curtains, clean curtain tracks, windows, ledges, remove waste, clean any equipment in room, clean high surfaces and touch points. Following issues, we are now developing SOPs, some that specifically have CROs in mind, that is, how to clean a bathroom and in what order objects are cleaned to reduce the risks of cross-transmission. We use a red, amber, green (RAG) system and an infection control cleaning regime for infectious patients, which specifies this type of cleaning and how it is triggered.” Cleaning leads, English National Health Service</p>

Table 11. Potential barriers and solutions (environmental cleaning), continued

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> Staff fearful of patients with CROs, resulting in overuse of unnecessary disinfectants. 	<ul style="list-style-type: none"> Fear can be greatly reduced by the education of hospital cleaning staff, health care workers and the IPC teams so that the transmission of CROs is understood and dealt with in a sensible manner. Use Table 9 to inform approaches and training packages. 	<p>Use of communication aids</p> <p>"We use a range of information leaflets with simple clear language for patients and staff and this is extremely useful." IPC lead, English National Health Service</p>
<ul style="list-style-type: none"> Lack of trained, competent staff to undertake supervision of the work of hospital cleaning staff. 	<ul style="list-style-type: none"> Discuss at the IPC committee level – consider the use of link or head of ward nurses to support the supervision of cleaning activities. 	<p>Feedback to drive motivation</p> <p>"Daily inspections can be done by immediate supervisors, weekly inspections by the IPC/WASH personnel and monthly inspections and grading by the IPC/WASH team. My experience has proven that grading and feedback stimulate and promote some competition and motivation between staff and departments."</p> <p>IPC lead, Cameroon</p> <p>Multidisciplinary inspections</p> <p>"We undertake frequent critical inspections by a multidisciplinary team (ward nurse manager, IPC and facilities). In outbreaks, these would also be enhanced by cleanliness audits." Cleaning leads, English National Health Service</p>
<ul style="list-style-type: none"> Lack of resources, including staff to conduct objective monitoring compounding low adherence to cleaning protocols. 	<ul style="list-style-type: none"> Consider use of checklists and bundles focused on high frequency touch surfaces. Document findings and establish robust, accessible systems of record-keeping, signed by the hospital cleaning staff each day. Feedback results to cleaning staff, hospital IPC and patient safety and quality committees to inform improvement (for example training and resource allocation). Be clear on audit of performance – it should not be undertaken by contractors/contracted supervisors, but under the leadership and supervision of the IPC team or in close collaboration with the IPC team. 	<p>The value of patient feedback</p> <p>"We use a general area-wide cleaning checklist, a checklist for curtain changing and patient feedback" IPC lead, Cancer hospital, India</p> <p>Use of fluorescent markers</p> <p>"We use reflective surface markers and monitor dilution of cleaning/disinfection products by undertaking random observation checks on the dilution procedure. We also check for damaged furniture (and replace). We do not advise to use visual inspection." IPC lead, Médecins Sans Frontières/Doctors Without Borders</p> <p>Use of environmental cultures</p> <p>"We always culture if we have concerns about outbreaks – we do not use fluorescent markers, but these are good for visual impact assessment and teaching. ATPase is not really useful given that it only picks up organic matter and not what it is [the organism], but it does give an indication of effective cleaning." Cleaning leads, English National Health Service</p> <p>Use of technology</p> <p>"We have intermittently checked the chlorine levels of hypochlorite stock or diluted solutions using electronic chlorine meters." IPC lead, Cancer hospital, India</p>

Table 11. Potential barriers and solutions (environmental cleaning), continued

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> Lack of visual reminders to support the work of hospital cleaning staff, for example, door signage information, or information available, but not in local languages. 	<ul style="list-style-type: none"> Reminders developed in the local language with local partners and nongovernmental organizations. Use end of bed (for example on patient chart) and/or door signage to reinforce correct procedures, maximizing use of visuals/ non-written material and focusing on local languages. 	<p>Electronic flagging</p> <p>“Electronic flagging (or flagging medical records) of positive patients is valuable for patients who return to the same hospital.” IPC lead, English National Health Service</p> <p>Use of colour-coding</p> <p>“We have used a red coloured ‘safety first’ signage (hung from patient bed rails) to alert housekeeping staff and other health care workers that the patient is colonized or infected with a multidrug-resistant organism. This acts as a visual reminder for concerned staff without compromising on patient confidentiality.” IPC lead, Cancer hospital, India</p>
<ul style="list-style-type: none"> IPC teams not involved in the selection of contract companies for external cleaning services – reflective of a general lack of understanding by senior managers of the role and value of cleaning. 	<ul style="list-style-type: none"> Undertake the IPCAF to gather information to drive action by senior managers. Use cost-effectiveness data focusing on the cost-benefit of cleaning (where available). IPC team to convince senior managers to champion cleaning within the hospital as part of patient and staff dignity/rights. Establish regular contact and communication between hospital cleaning staff and hospital leaders/managers, for example, provision of positive feedback. 	<p>Critical role of IPC practitioner in leadership engagement</p> <p>“One of the many jobs of the infection preventionist in my hospital is to lead and also to liaise with the top leadership of the organization, society and the state in a manner which enables the facility aspect to be enhanced so that the implementation of key policies can happen at all levels. Leadership is the agent of change which makes this possible.” IPC lead, Cancer hospital, India</p>

Table 11. Potential barriers and solutions (environmental cleaning), continued

Potential barrier(s)/problem(s)	Potential solution(s)	Implementation examples
<ul style="list-style-type: none"> The role of hospital cleaning staff is undervalued and cleaning has a low organizational priority reflected in the low salaries of hospital cleaning staff. 	<ul style="list-style-type: none"> Develop selection criteria for hospital cleaning staff and supervisors, including external contractors, and discuss with senior management adequate salary rates according to roles and responsibilities. Ensure hospital cleaning supervisors and managers are a core part of the hospital management structure and listened to in decision making. Assign hospital cleaning staff to a service/unit to be part of the 'team'. Include hospital cleaning supervisors/managers in IPC and other relevant teams and committees – elevate recognition of their critical role – send a strong message across the organization. Organize a day of support for hospital cleaning staff – similar to hand hygiene and other awareness days, for example, IPC teams can break down barriers and involve cleaning staff in World Hand Hygiene Day (May 5). 	<p>Use of incentives</p> <p>"We implemented a 'best employee of the month' award and give a certificate and gift voucher. The best groomed staff of the month also gets a certificate and gift voucher. In addition, long-serving housekeeping staff are given rewards in acknowledgement of their services and commitment and dedication." IPC lead, Cancer Hospital, India</p> <p>"In our hospital we have developed a local programme that seeks to address motivation and value, including provision of prizes for the best/cleanest areas. This seems to work well." IPC physician, South Africa</p> <p>Participatory approach</p> <p>"Including cleaners as part of the IPC team and getting them to present audit results is very powerful, particularly in outbreak situations, I have seen people value the role much more." IPC physician, South Africa</p> <p>"During some ongoing outbreaks of CPE, we found that shower drains were not being cleaned routinely. This meant that they were frequently found to be "gunky". Senior leaders in the hospital estates department brought together a stakeholder group including contract cleaners and other estates contracts, IPC and ward staff to implement first a one-off thorough clean and "degunk" of all shower drains in the affected wards, and secondly, a robust process for the regular cleaning of drains across our group of hospitals. This process is in the final stages of design before being implemented." IPC lead, English National Health Service</p>
<ul style="list-style-type: none"> Concerns that cleaning standards will be negatively impacted due to outsourcing. 	<ul style="list-style-type: none"> Use mandated guidelines to highlight clear responsibilities of outsourced services. 	<p>The power of national guidelines</p> <p>"When sanitation services are being outsourced, the contract must clearly define the infection control-related responsibilities. These should include the outsourced agency's responsibility for employee health and mandatory training. In India, we have clear <i>National guidelines for clean hospitals</i> to support local work." IPC lead, Cancer Hospital, India</p>
<ul style="list-style-type: none"> Criticism of the cleanliness of a ward by patients and families may have a negative impact on the morale of cleaning staff (who face multiple challenges as outlined here) that negatively impacts on performance, thus making the situation worse. 	<ul style="list-style-type: none"> Develop a standard format for patient feedback. 	<p>"Patient-Led Assessment of Cleaning of the Environment (PLACE) is a United Kingdom initiative that has been published. A team of patient volunteers join with staff and undertake walk-arounds, speaking with patients and staff." IPC lead, English National Health Service</p>

BOX 27. SUGGESTED CONTENT FOR SOPs FOR ENVIRONMENTAL CLEANING

1. Recommended standard technique/procedure for cleaning.
2. Dilution of disinfectants and detergents.
3. Optimal cleaning frequency.
4. Cleaning agents (and disinfectants), materials for cleaning.
5. Selection and maintenance of cleaning materials and equipment.
6. Standards for selection, recruitment, training, evaluation and optimal ratio of cleaning staff.
7. Safety standards for hospital cleaning staff (and other health care staff who clean).
8. Roles and responsibilities of cleaning.
9. Cleaning checklist (or audit) for environment and equipment.
10. Features of facility design for optimal cleaning (utility room, location of sink, materials of surfaces, design of sink/water flow).
11. Source of water to be used for cleaning (including contingency plans in case of water shortage) and water quality standards for cleaning.

BOX 28. EXAMPLE INDICATORS FOR MONITORING ENVIRONMENTAL CLEANING

Structural indicators

- Availability of cleaning protocols and procedures/SOPs
- Availability of adequate human resources for cleaning (including supervisors and/or overall managers/focal person(s) for the cleaning programme).
- Availability of cleaning resources (detergents, disinfectants, water, mops, dusters).
- Audit of damaged equipment and surfaces (which may not be adequately cleaned).
- Audit of the condition of cleaning resources – for example, expired chemicals, damaged/malfunctioning cleaning equipment (mops, buckets).

Process indicators

- Preparation of products, for example, accurate dilution of detergents/disinfectants.
- Performance observation (that is, actual observation of cleaning practice/technique); time-consuming in the context of CRO prevention and control (particularly during outbreaks), this type of monitoring can be warranted, possibly even more so than visual assessment of cleanliness. Performance observation can include:
 - ▷ appropriateness of contact times;
 - ▷ frequency of cleaning/drying times;
 - ▷ adherence to correct techniques (for example, not double-dipping cloths, proceeding from clean to dirty, etc.);
 - ▷ consumption of cleaning resources;
 - ▷ correct disposal of cleaning solutions.

Outcome indicators (see Annex 5 “Summary of monitoring methods for environmental cleaning for additional information to guide decision making”)

- Direct observation:
 - ▷ visual inspection as a first step in checking cleaning – not reliable if used alone.
- Indirect observation:
 - ▷ patient/resident satisfaction surveys.
- Environmental indicators of thoroughness of cleaning and cleanliness:
 - ▷ environmental cultures – measures the presence of specific bacteria on a surface and can be useful for epidemiological purpose in outbreaks only;
 - ▷ fluorescent marker systems – colourless solutions are applied to the surfaces prior to cleaning; after cleaning, any area not properly cleaned is detected using fluorescence under ultraviolet light (this method of measurement was addressed within conditional recommendation 7 of the CRO guidelines and provides immediate feedback).
 - ▷ Adenosine triphosphate: provides a quantitative measure of the amount of bioburden present (pre- and post-cleaning), but no correlation with viable microorganisms and no defined threshold to correlate with cleanliness.

NEW GUIDANCE TOOL FOR LOW- AND MIDDLE-INCOME SETTINGS

A new guidance document entitled *Best Practices for Environmental Cleaning in Healthcare Facilities for Limited-resource Settings* is under development as part of a collaborative project including CDC, Infection Control Africa Network (ICAN), WHO and ministries of health. It will summarize not only current best practices for environmental cleaning and disinfection, but also best practices for implementing cleaning programmes. An accompanying toolkit will be developed to: (a) introduce key cleaning programme elements and indicators; (b) provide a structured approach for cleaning programme planning and improvement; and (c) provide tools for implementing a cleaning programme. This guidance document and its toolkit will be a critical resource to support routine environmental cleaning and a key partner resource to this chapter.

TOOLS AND RESOURCES

WHO and other agency supporting tools already available

General IPC implementation resources

- WHO core component implementation resources (<http://www.who.int/infection-prevention/tools/core-components/en/>, accessed 12 February 2019).
- WHO Interim practical manual supporting implementation of the WHO Guidelines on core components of infection prevention and control programmes. Geneva: World Health Organization; 2018 (<http://www.who.int/infection-prevention/tools/core-components/facility-manual.pdf>; see in particular: Sample action plan: built environment, materials and equipment for IPC, page 99).

Hand hygiene tools

- WHO hand hygiene tools for system change (http://www.who.int/infection-prevention/tools/hand-hygiene/system_change/en/, accessed 12 February 2019).

WASH tools

- WHO Essential environmental health standards in health care (http://www.who.int/water_sanitation_health/publications/ehs_hc/en/, accessed 12 February 2019).
- WHO Water and sanitation for health facility improvement tool (WASH FIT) (https://www.who.int/water_sanitation_health/publications/water-and-sanitation-for-health-facility-improvement-tool/en/, accessed 12 February 2019).
- WASH FIT digital (<https://washfit.org>, accessed 12 February 2019).
- WHO Guidelines for drinking-water quality. 4th edition, incorporating the 1st addendum (https://www.who.int/water_sanitation_health/publications/drinking-water-quality-guidelines-4-including-1st-addendum/en/, accessed 12 February 2019).
- Tackling antimicrobial resistance: supporting national measures to address IPC and WASH in health care settings (https://www.washinhcf.org/fileadmin/user_upload/documents/AMR_IPC_WASH_FlyerNov2016-1.pdf).

Risk assessment tools

- The risk stratification matrix is reproduced directly in Annex 2 from the Ontario Agency for Health Protection and Promotion (Public Health Ontario), Provincial Infectious Diseases Advisory Committee. Best practices for environmental cleaning for prevention and control of infections in all health care settings. 3rd ed. Toronto, ON: Queen's Printer for Ontario; 2018 (https://www.publichealthontario.ca/en/eRepository/Best_Practices_Environmental_Cleaning.pdf).

Built environment tools

- The Joint Commission. Planning, design, and construction of health care facilities. Addressing Joint Commission and JCI standards and other considerations— from planning to commissioning. 3rd edition. 2015 (<http://www.jointcommissioninternational.org/assets/1/14/EBPDC15Sample.pdf>)
- WHO Essential environmental health standards in health care (http://www.who.int/water_sanitation_health/publications/ehs_hc/en/, accessed 12 February 2019)
- Health Building Note 00-09: Infection control in the built environment. Department of Health, United Kingdom (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/170705/HBN_00-09_infection_control.pdf)

WHO and other agency supporting tools already available

Best practice cleaning guidance/guidelines

- Ontario Agency for Health Protection and Promotion (Public Health Ontario), Provincial Infectious Diseases Advisory Committee. Best practices for environmental cleaning for prevention and control of infections in all health care settings. 3rd ed. Toronto, ON: Queen's Printer for Ontario; 2018 (https://www.publichealthontario.ca/en/eRepository/Best_Practices_Environmental_Cleaning.pdf).
- British Columbia Best practices for environmental cleaning in all healthcare settings and programs, 2016 (<https://picnet.ca/wp-content/uploads/British-Columbia-Best-Practices-for-Environmental-Cleaning-for-Prevention-and-Control-of-Infections-in-All-Healthcare-Settings-and-Programs.pdf>).
- National Patient Safety Agency. The national specifications for cleanliness in the NHS: guidance on setting and measuring cleanliness outcomes in primary care medical and dental premises, 2010 (<http://www.faad.co.uk/Includes/NPSA%20cleaning%20specification.pdf>).
- National Patient Safety Agency The NHS cleaning manual, 2014 (<http://infectioncontrol.calderdale.gov.uk/wp-content/uploads/2014/09/NHS-Cleaning-Manual-Final-V21.pdf>).
- Cleaning standards for South Australian Healthcare Facilities. Government of South Australia, December 2017 (https://www.sahealth.sa.gov.au/wps/wcm/connect/18741180499970f0891e8faa8650257d/SA-Health-cleaning-standard-2014_%28v1.1%29-cdc-ics-20180301.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-18741180499970f0891e8faa8650257d-mxU4hUW).
- National guidelines for clean hospitals. Applicable to tertiary care hospitals, hospitals associated with medical colleges & super-specialty hospitals in India. Ministry of Health and Family Welfare. Government of India (https://mohfw.gov.in/sites/default/files/7660257301436254417_0.pdf).
- CDC, ICAN Best Practices for Environmental Cleaning in Healthcare Facilities for Limited-resource Settings 2019 (<http://www.icanetwork.co.za/icanguideline2019/>).
- Health Service Executive (Ireland). HSE national cleaning manual, acute hospitals, 2005 (<https://www.hse.ie/eng/services/publications/hospitals/hse-national-cleaning-standards-manual.html>).

Training tools

- CDC Environmental learning and disinfection e-learning module(<https://ipc.ghelearning.org>)
- TEACH CLEAN package: The Soapbox Collaborative (http://soapboxcollaborative.org/?page_id=5512).

WHO and other agency supporting tools already available

Cleaning monitoring/assessment tools

- WHO Infection prevention and control assessment framework (IPCAF) (<http://www.who.int/infection-prevention/tools/core-components/IPCAF-facility.PDF>).
- CDC Options for evaluating environmental cleaning (<https://www.cdc.gov/hai/toolkits/evaluating-environmental-cleaning.html>).

Bundles

- Havill NL. Best practices in disinfection of noncritical surfaces in the health care setting: creating a bundle for success. *Am J Infect Control* 2013;41(Suppl.): S26-30 (<https://www.ncbi.nlm.nih.gov/pubmed/23622744>).

Sample procedures

- Ontario Agency for Health Protection and Promotion (Public Health Ontario), Provincial Infectious Diseases Advisory Committee. Best practices for environmental cleaning for prevention and control of infections in all health care settings. 3rd ed. Toronto, ON: Queen's Printer for Ontario; 2018 (https://www.publichealthontario.ca/en/eRepository/Best_Practices_Environmental_Cleaning.pdf); see sample procedures relating to:(a) routine daily cleaning of patient/resident room; (b) routine bathroom cleaning; (c) routine discharge/transfer cleaning of a patient/resident room; (d) enhanced shower and sink cleaning).

Scientific literature

- Collett S, Samarin I, Bhalchandra R, Soundaranayagam JR, Garai S, Chandy M, et al. Water usage in a multi-speciality hospital and its effective management et al. *Water usage in a multi-speciality hospital and its effective management*. *J Acad Clin Microbiol*. 2016;18: 135-37
- Dumigan DG, Boyce JM, Havill NL, Golebiewski M, Balogun O, Rizvani R. Who is really caring for your environment of care? Developing standardized cleaning procedures and effective monitoring techniques. *Am J Infect Control*. 2010;38:387-92
- Dancer SJ. Controlling hospital-acquired infection: focus on the role of the environment and new technologies for decontamination. *Clin Microbiol Rev* 2014;27: 665-90;
- Dancer SJ. Dos and don'ts for hospital cleaning. *Curr Opin Infect Dis*. 2016;29: 415-23;
- Dancer SJ, Kramer A. Four steps to clean hospitals: look; plan; clean; and dry. *J Hosp Infect*. 2018 Dec 27. pii: S0195-6701(18)30720-5. doi: 10.1016/j.jhin.2018.12.015.

USE OF TOOLS TO SUPPORT IMPLEMENTATION OF ENVIRONMENTAL CLEANING

Box 29 presents an example of where a tool has been used to support the implementation of environmental cleaning and summarizes some key lessons that might be useful for those considering using the tools to strengthen their approach to the prevention and control of CROs. These examples will be expanded on over time.

BOX 29. THE TEACH CLEAN TRAINING PACKAGE AN EXAMPLE OF HOW TOOLS SUPPORT PRACTICE

The TEACH CLEAN training package (teachclean@soapboxcollaborative.org) has been used in four countries, with wider dissemination now underway. The package was developed by The Soapbox Collaborative (www.soapboxcollaborative.org) in response to findings from needs assessments of the state of IPC on maternity wards across eight LMICs. These revealed a stark lack of training of health workers whose primary role is environmental cleaning – individuals usually referred to as “cleaners”. These frontline workers are often neglected in terms of their working conditions, as well as their right to an understanding of IPC and infection risks to themselves and to patients. Such workers often also have low literacy and are unfamiliar with traditional training methods, such as formal workshops. TEACH CLEAN was designed to help fill this training gap and adopts a participatory learning approach with an emphasis on practical demonstrations. The package comprises 7 specific learning modules covering the main areas of IPC, guidance on how to teach these, and a set of guidelines based on existing cleaning best practices and policies. TEACH CLEAN fits well with a cascade approach to training in a country. It commences with identifying a training institute and master trainers at national or regional levels, who then both adapt the package to ensure consistency with local cleaning guidance and train cleaning ‘champions’ (supervisors) from specific healthcare facilities. These champions in turn train cleaners in their facility. Additional modules have recently been added (a) to orientate trainers to using supportive supervision and competency-based assessment to monitor cleaners after training; and (b) to ensure that the crucial practice of effective cleaning is fully embedded in the wider area of quality improvement in healthcare facilities. The early applications of TEACH CLEAN have provided a number of insights relevant to further roll-out, such as its relevance both to other health care workers as well as cleaners and to non-maternity wards. Positive experiences have been fed back from applications in Gambia, India and Cameroon and a robust research evaluation is currently underway in Tanzania.

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2. Global guidelines for the prevention of surgical site infection. Geneva: World Health Organization; 2016 (<https://apps.who.int/iris/bitstream/handle/10665/277399/9789241550475-eng.pdf?ua=1>, accessed 12 February 2019).
3. Decontamination and reprocessing of medical devices for health-care facilities. Geneva: World Health Organization and Pan American Health Organization; 2016 (<https://apps.who.int/iris/bitstream/handle/10665/250232/9789241549851-eng.pdf?sequence=1>).
4. Ontario Agency for Health Protection and Promotion (Public Health Ontario) PIDAC. Best practices for environmental cleaning for prevention and control of infections in all health care settings. 3rd ed. Toronto, ON: Queen's Printer for Ontario; 2018 (https://www.publichealthontario.ca/en/eRepository/Best_Practices_Environmental_Cleaning.pdf).
5. Essential environmental health standards in health care. Geneva: World Health Organization; 2008 (http://www.who.int/water_sanitation_health/publications/ehs_hc/en/, accessed 12 February 2019).
6. Adugna D JM, Lemma B, Gebrie GS. Assessing the potential for rooftop rainwater harvesting from large public institutions. *Int J Environ Res Public Health* 2018;15: pii: E336.

ANNEX 1. NATIONAL INFECTION PREVENTION AND CONTROL (IPC) CORE COMPONENT CHECKLIST

Core component	Recommendation	Checks to support implementation	Reference
1. IPC programmes	Establish active, stand-alone IPC programme for the purpose of preventing HAI and combating AMR through IPC good practices.	<input type="checkbox"/> Programme objectives, functions, and activities clearly outlined <input type="checkbox"/> Technical team of trained infection preventionists in place <input type="checkbox"/> Dedicated IPC budget allocated <input type="checkbox"/> Evidence that the IPC programme is linked with other relevant programmes and professional organizations	Practical manual Chapter 1
2. Evidence-based guidelines	Develop evidence-based national IPC guidelines and related implementation strategies. Ensure health care workers education and training on guideline recommendations and systems monitoring adherence with guideline recommendations.	<input type="checkbox"/> Essential IPC guidelines developed or adapted from international standards <input type="checkbox"/> Necessary infrastructure and supplies to enable guideline implementation in place/being addressed <input type="checkbox"/> Measures to support and mandate health care worker education and training on the guidelines' in place <input type="checkbox"/> System to monitor adherence with guideline recommendations in place	Practical manual Chapter 2
3. Education and training	Support IPC education and training of the health workforce.	<input type="checkbox"/> Curricula target audience, learning objectives, competencies and teaching strategy developed <input type="checkbox"/> Pre-graduate curricula developed or under development <input type="checkbox"/> Post-graduate IPC curricula developed or under development <input type="checkbox"/> New employee orientation and in-service continuous training on IPC developed or under development	Practical manual Chapter 3
4. Surveillance	Establish HAI surveillance programmes and networks that include mechanisms for timely feedback and can be used for benchmarking purposes.	<input type="checkbox"/> Support and engagement by governments and authorities for IPC surveillance secured <input type="checkbox"/> Human and financial resources secured <input type="checkbox"/> Adequate microbiology and laboratory capacity and quality in place or under development - at least in national reference laboratories <input type="checkbox"/> Surveillance strategy developed <ul style="list-style-type: none"> • Clear objectives • Standardized case definitions • Methods • Process for data analysis, reporting, and evaluation of data quality <input type="checkbox"/> Specific training for data collectors established	Practical manual Chapter 4

<p>5. Multimodal strategies</p>	<p>Coordinate and facilitate the implementation of IPC activities through multimodal strategies adapted to the local context.</p>	<p> <input type="checkbox"/> Multimodal implementation strategies according to WHO definitions identified and actively promoted to prevent specific types of HAIs and/or AMR <input type="checkbox"/> Requisite funding identified to support a multimodal approach <input type="checkbox"/> Evidence of IPC integration with other quality improvement/safety/accreditation programmes demonstrated <input type="checkbox"/> Evidence of local adaptation of multimodal implementation strategies demonstrated <input type="checkbox"/> Evidence of monitoring compliance with the strategies and impact of the intervention on desired outcomes demonstrated </p>	<p>Practical manual chapter 5</p>
<p>6. Monitoring, audit and feedback</p>	<p>Establish a monitoring and evaluation programme to assess the extent to which standards are being met and activities are being performed according to the programme's goals and objectives. Consider using hand hygiene monitoring with feedback as a key performance indicator.</p>	<p> <input type="checkbox"/> Hand hygiene monitoring with feedback established as a key performance indicator at national level <input type="checkbox"/> Other important IPC process indicators determined <input type="checkbox"/> Strategy for using the data for action developed <input type="checkbox"/> Regular reports produced and distributed </p>	<p>Practical manual Chapter 6</p>
<p>7.*</p>			
<p>8.*</p>			
<p>9.*</p>			

*Can be added according to the local context

ANNEX 2. EXAMPLE OF A RISK STRATIFICATION MATRIX TO DETERMINE FREQUENCY OF CLEANING

The risk stratification matrix is reproduced directly from the Ontario Agency for Health Protection and Promotion (Public Health Ontario), Provincial Infectious Diseases Advisory Committee. *Best practices for environmental cleaning for prevention and control of infections in all health care settings*. 3rd ed. Toronto, ON: Queen's Printer for Ontario; 2018. (https://www.publichealthontario.ca/en/eRepository/Best_Practices_Environmental_Cleaning.pdf)

FOR EACH CLIENT/PATIENT/RESIDENT AREA OR DEPARTMENT:

STEP 1: CATEGORIZE THE FACTORS THAT WILL IMPACT ON ENVIRONMENTAL CLEANING:

Probability of contamination with pathogens

Heavy contamination (score = 3)

An area is designated as being heavily contaminated if surfaces and/or equipment are routinely exposed to copious amounts of fresh blood or other body fluids (e.g., birthing suite, autopsy suite, cardiac catheterization laboratory, hemodialysis station, Emergency room, client/patient/resident bathroom if visibly soiled).

Moderate contamination (score = 2)

An area is designated as being moderately contaminated if surfaces and/or equipment does not routinely (but may) become contaminated with blood or other body fluids and the contaminated substances are contained or removed (e.g., wet sheets). All client/patient/resident rooms and bathrooms should be considered to be, at a minimum, moderately contaminated.

Light contamination (score = 1)

An area is designated as being lightly contaminated if surfaces are not exposed to blood, other body fluids or items that have come into contact with blood or body fluids (e.g., lounges, libraries, offices).

Vulnerability of population to environmental infection

More susceptible (score = 1)

Susceptible clients/patients/residents are those who are most susceptible to infection due to their medical condition or lack of immunity. These include those who are immunocompromised (oncology, transplant and chemotherapy units), neonates (level 2 and 3 nurseries) and those who have severe burns (i.e., requiring care in a burn unit).

Less susceptible (score = 0)

For the purpose of risk stratification for cleaning, all other individuals and areas are classified as less susceptible.

Potential for exposure

High-touch surfaces (score = 3)

High-touch surfaces are those that have frequent contact with hands. Examples include doorknobs, telephone, call bells, bedrails, light switches, wall areas around the toilet and edges of privacy curtains.

Low-touch surfaces (score = 1)

Low-touch surfaces are those that have minimal contact with hands. Examples include walls, ceilings, mirrors and window sills.

STEP 2: DETERMINE THE TOTAL RISK STRATIFICATION SCORE:

For each functional area or department, the frequency of cleaning is based on the factors listed in the boxes above. A score is given if the factors are present, and the frequency of cleaning is based on the total score as derived in the following matrix:

Risk stratification scores for high-touch surfaces (score for potential for exposure = 3)

Probability of contamination with pathogens		More susceptible population (score = 1)	Less susceptible population (score = 0)
Heavy (score = 3)		7 (3+3+1)	6 (3+3+0)
Moderate (score = 2)		6 (3+2+1)	5 (3+2+0)
Light (score = 1)		5 (3+1+1)	4 (3+1+0)

Risk stratification scores for low-touch surfaces (score for potential for exposure = 1)

Probability of contamination with pathogens	More susceptible population (score = 1)		Less susceptible population (score = 0)
Heavy (score = 3)	5 (1+3+1)		4 (1+3+0)
Moderate (score = 2)	4 (1+2+1)		3 (1+2+0)
Light (score = 1)	3 (1+1+1)		2 (1+1+0)

STEP 3: DETERMINE THE CLEANING FREQUENCY BASED ON THE RISK STRATIFICATION MATRIX:

Cleaning frequencies for each functional area or department are derived from the total score that results from the risk stratification matrix above:

Cleaning frequencies based on total risk score

Total Risk Score	Risk Type		Minimum Cleaning Frequency
7	High risk		Clean after each case/event/ procedure and Clean additionally as required
4-6	Moderate risk		Clean at least once daily Clean additionally as required (e.g., gross soiling)
2-3	Low risk		Clean according to a fixed schedule Clean additionally as required (e.g., gross soiling)

To see examples using the risk stratification matrix to determine the cleaning frequency of specific areas, refer to pages 160-64 of the document.

ANNEX 3. RISK STRATIFICATION – ILLUSTRATIVE EXAMPLE*

Here is an example of using the risk stratification matrix to determine the cleaning approach within the context of CROs.

Example scenario: The risk stratification exercise has been used to support decision-making with reference to the cleaning approach and frequency for the patient zone of a patient in a general surgical ward. The patient has a postoperative wound infection with a confirmed CRO and is suffering from diarrhoea that is resulting in some faecal incontinence and contamination of the bedding in the patient zone.

Location	Probability of contamination: light = 1 moderate = 2 heavy = 3	Potential for exposure: high touch = 3 Low touch = 1	Population: less susceptible = 0 more susceptible = 1	Total score	Interpretation
Patient zone of patient with CRO in side room of a general surgical ward	3	3	1	7	<ul style="list-style-type: none"> • Clean after each case/event/ procedure and at least twice per day • Clean additionally as required.

*Ontario Agency for Health Protection and Promotion (Public Health Ontario). Provincial Infectious Diseases Advisory Committee. Risk stratification matrix to determine frequency of cleaning in Ontario. Best practices for environmental cleaning for prevention and control of infections in all health care settings. 3rd ed. Toronto, ON: Queen's Printer for Ontario; 2018 (https://www.publichealthontario.ca/en/eRepository/Best_Practices_Environmental_Cleaning.pdf).

ANNEX 4. PRODUCTS USED IN ENVIRONMENTAL CLEANING*

Product	Advantage	Disadvantage	Antimicrobial efficacy	Use
Neutral detergent	<ul style="list-style-type: none"> • Good material compatibility. • Good/essential for soil removal. 	<ul style="list-style-type: none"> • Some data demonstrate that enzymatic cleaning products are more effective than neutral detergents in removing microorganisms from surfaces. 	<ul style="list-style-type: none"> • Not a disinfectant. • Cleaning reduces microbial load through chemical and mechanical action. 	<ul style="list-style-type: none"> • Critical role in removal of soil and spillages including prior to disinfection.
Alcohol 60–70% (ethanol or isopropanol)	<ul style="list-style-type: none"> • Rapidly bactericidal; • non-toxic. • Stable in closed containers. • Low cost. • Rapid action. • Non-staining. • No residue. • Effective on clean equipment/surfaces. • Non-irritant. 	<ul style="list-style-type: none"> • Inactivated by organic matter. • Evaporates quickly. • Flammable – store in a cool well-ventilated area. • Can damage /corrode some surfaces, for example, rubber/plastic. 	<ul style="list-style-type: none"> • Good activity against bacteria, mycobacteria. • Moderate activity against enveloped and non-enveloped viruses. • No activity or insufficient against spores. 	<ul style="list-style-type: none"> • Can be used on external surfaces of some equipment. • Disinfection achieved after 10 minutes of contact.
Chlorine releasing agents (for example, sodium hypochlorite, bleach 0.5%-1% available chlorine or 5000-10,000ppm)	<ul style="list-style-type: none"> • Low cost. • Rapid action. • Broad spectrum including spores. • Relatively safe. • Readily available in most countries. 	<ul style="list-style-type: none"> • Corrosive to metals. • Inactivated by organic materials – for blood spills, blood must be removed prior to disinfection. • Irritant/sensitizing agent - reported to cause respiratory and skin irritation and allergic reactions and one of the leading allergens affecting health care providers. • Stains clothing and carpets. • Corrosive/damaging. • Not stable once made. 	<ul style="list-style-type: none"> • Good activity against bacteria, mycobacteria, spores, enveloped and non-enveloped viruses. 	<ul style="list-style-type: none"> • Spill management; disinfection of countertops and floors. • Use immediately once diluted. • Use in well-ventilated areas. • Store in closed containers away from heat and light to prevent deterioration.
Hydrogen peroxide	<ul style="list-style-type: none"> • Stable under normal conditions, (for example, when stored in dark containers). • Non-toxic. • Rapid action. • Active in the presence of organic material. 	<ul style="list-style-type: none"> • Corrosive/damaging to a number of surfaces (for example, copper, brass, carbon-tipped devices, anodized aluminium). • Expensive. • Irritant/sensitizing agent - reported to cause respiratory and skin irritation and allergic reactions and one of the leading allergens affecting health care providers. 	<ul style="list-style-type: none"> • Active against a wide range of microorganisms, including bacteria, yeasts, fungi, viruses, and spores. 	<ul style="list-style-type: none"> • Can be used for environmental cleaning under controlled conditions due to harmful effects on humans.

Annex 4, continued

Product	Advantage	Disadvantage	Antimicrobial efficacy	Use
Clear soluble phenolics (1-2%)	<ul style="list-style-type: none"> Stable. Not inactivated by organic material. 	<ul style="list-style-type: none"> Slightly corrosive/damaging. Irritant/sensitizing agent - reported to cause respiratory and skin irritation and allergic reactions and one of the leading allergens affecting health care providers. 	<ul style="list-style-type: none"> Good activity against bacteria. Moderate activity against mycobacteria and enveloped viruses. No activity or insufficient against spores. Variable activity against non-enveloped viruses. 	<ul style="list-style-type: none"> Not recommended.
Quaternary ammonium (also known as QATs)	<ul style="list-style-type: none"> Good cleaning ability and considered to be gentle (non-corrosive and non-staining) on surfaces. 	<ul style="list-style-type: none"> Variable stability. Inactivated by organic material. Slight corrosive/damaging to materials. Irritant/sensitizing agent - reported to cause respiratory and skin irritation and allergic reactions and one of the leading allergens affecting health care providers. 	<ul style="list-style-type: none"> Variable to moderate activity against bacteria – overall antimicrobial activity relatively limited. Less effective against Gram-negative bacteria. No activity or insufficient activity against mycobacteria and spores. Variable activity against enveloped and non-enveloped viruses. 	<ul style="list-style-type: none"> Not recommended.

*Based on and adapted from:

- Ontario Agency for Health Protection and Promotion (Public Health Ontario) PIDAC. Best practices for environmental cleaning for prevention and control of infections in all health care settings. 3rd ed. Toronto, ON: Queen's Printer for Ontario; 2018 (https://www.publichealthontario.ca/en/eRepository/Best_Practices_Environmental_Cleaning.pdf).
- Provincial Infection Control Network of British Columbia (Canada). British Columbia Best practices for environmental cleaning for prevention and control of infections in all health care settings and programmes. 2016 (<https://picnet.ca/wp-content/uploads/British-Columbia-Best-Practices-for-Environmental-Cleaning-for-Prevention-and-Control-of-Infections-in-All-Healthcare-Settings-and-Programs.pdf>).
- Damani N. Manual of infection prevention and control. 4th ed. Oxford, UK: Oxford University Press; 2019.
- Dancer S. Controlling hospital-acquired infection: focus on the role of the environment and new technologies for decontamination. Clin Microbiol Rev 2014;27: 665-690.
- Weber JD, Rutala WA, Sickbert-Bennett EE. Outbreaks associated with contaminated antiseptics and disinfectants. Antimicrob Agents Chemother 2007;51: 4217-4224.

ANNEX 5. SUMMARY OF MONITORING METHODS FOR ENVIRONMENTAL CLEANING

Method	Ease of use	Cost	Identifies pathogens	Useful for teaching	Additional comments
Visual inspection	Simple	Minimal	No	Yes	<ul style="list-style-type: none"> • Easy to implement. However, visible checks alone are not enough and do not provide a reliable assessment of cleanliness. • Emphasis on visible dirt/soiling only. • Assessment is subjective and results may vary across different inspectors.
Fluorescent marker systems	Relatively simple	Relatively less expensive than other methods	No	Yes	<ul style="list-style-type: none"> • Apply clear marker/gel to high-touch surfaces in patient/resident rooms prior to cleaning, then evaluate to see if the marker/gel was removed by cleaning. • Provides immediate and objective feedback to cleaning staff. • The marker may not be available in some countries.
ATP system (adenosine triphosphate)	Relatively simple	Expensive (requires special equipment and swabs)	No	Yes	<ul style="list-style-type: none"> • ATP is a chemical substance that is present in all living cells, including bacteria and viruses, but can also be confounded by the presence of bleach, microfibre products and manufactured plastics used in cleaning. • Provides quantitative measure of the amount of bioburden present. • Relative light unit measurements do not correlate precisely with microbial counts as readings occur with residual organic soil and dead bacteria. • Quick results.
Culture methods (swab or agar plate)	Relatively complex	Expensive and requires provision of laboratory support	Yes (bacteria only)	Yes	<ul style="list-style-type: none"> • Results not available for 48 hours. • There is no clear evidence on what are the accepted international standards for 'microbial cleanliness' • Useful to establish an epidemiology link during an outbreak. • Routine environmental swabbing is not recommended (no correlation with cleanliness).

Based on: Damani N. Manual of infection prevention and control. 4th ed. Oxford, UK: Oxford University Press; 2019.



World Health Organization

20 Avenue Appia
CH-1211 Geneva 27
Switzerland
Tel.: +41 22 791 5060

Email: savelives@who.int
Please visit us at:
<http://www.who.int/infection-prevention/en/>



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