



**Guidelines on Core Components
of Infection Prevention and Control
Programmes** at the National and Acute
Health Care Facility Level



World Health
Organization

Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level.

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Acronyms

AMR	antimicrobial resistance
CINAHL	Cumulative Index to Nursing and Allied Health Literature
EMBASE	Excerpta Medica Database
EPOC	Effective practice and organisation of care
GDG	Guidelines Development Group
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HAI	health care-associated infection
ICROMS	Integrated quality criteria for review of multiple study designs
ICU	intensive care unit
IHR	International Health Regulations
IPC	infection prevention and control
LMICs	low- and middle-income countries
MRSA	methicillin-resistant <i>Staphylococcus aureus</i>
PICO	Population (P), intervention (I), comparator (C) and outcome(s) (O)
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
RCT	randomized controlled trial
SDG	Sustainable Development Goals
SIGHT	Systematic review and evidence-based guidance on organization of hospital infection control programmes
SSI	surgical site infections
UK	United Kingdom
USA	United States of America
WASH	Water sanitation and hygiene
WHO	World Health Organization

Glossary of terms

Acute health care facility: A setting used to treat sudden, often unexpected, urgent or emergent episodes of injury and illness that can lead to death or disability without rapid intervention. The term *acute care* encompasses a range of clinical health care functions, including emergency medicine, trauma care, pre-hospital emergency care, acute care surgery, critical care, urgent care and short-term inpatient stabilization.

Alcohol-based handrub: 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 and other active ingredients with excipients and humectants.

Bundle: An implementation tool aiming to improve the care process and patient outcomes in a structured manner. It comprises a small, straightforward set of evidence-based practices (generally 3 to 5) that have been proven to improve patient outcomes when performed collectively and reliably.

Good practice statement: A code of conduct that aims to provide a clear and simple overview of the principles, policies and practices required to implement effective measures for infection prevention and control.

Grading of Recommendations

Assessment, Development and Evaluation (GRADE): an approach used to assess the quality of a body of evidence and to develop and report recommendations.

Health care-associated infection (also referred to as “nosocomial” or “hospital infection”): 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 associated with patient care.

Health care-associated infection point prevalence: The proportion of patients with one or more active health care-associated infections at a given time point.

Health care-associated infection incidence: The number of new cases of health care-associated infections occurring during a certain period in a population at risk.

Improved water source: Defined by the WHO/UNICEF Joint Monitoring Programme as a water source that by its nature of construction adequately protects the source from outside contamination, particularly faecal matter. Examples include: public taps or standpipes, protected dug wells, tube wells or boreholes.

Source: WHO/UNICEF. Progress on sanitation and drinking water: 2015 update and MDG assessment, 2015 (http://files.unicef.org/publications/files/Progress_on_Sanitation_and_Drinking_Water_2015_Update_.pdf).

Improved sanitation facilities: Toilet facilities that hygienically separate human excreta from human contact. Examples include flush/pour flush to a piped sewer system, septic tank or pit latrine, ventilated pit latrine, pit latrine with slab or composting toilet.

Low- and middle-income countries: WHO Member States are grouped into income groups (low, lower-middle, upper-middle, and high) based on the World Bank list of analytical income classification of economies for fiscal year 2014, calculated using the *World Bank Atlas method*. For the current 2016 fiscal year, low-income economies are defined as those with a gross national income per capita of US\$ 1045 or less in 2014; middle-income economies are those with a gross national income per capita of more than US\$ 1045, but less than US\$ 12 736; high-income economies are those with a gross national income per capita of US\$ 12 736 or more. (Lower-middle-income and upper-middle-income economies are separated at a gross national income per capita of US\$ 4125.)

Multimodal strategy: A multimodal strategy comprises several elements or components (three or more; usually five, <http://www.ihi.org/topics/bundles/Pages/default.aspx>) 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 components 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.

Declarations of interest

In accordance with WHO policy, all members of the Guidelines Development Group (GDG) were required to complete and submit a WHO Declaration of Interest form before each meeting. External reviewers and experts who conducted the systematic reviews were also required to submit a Declaration of Interest form. The secretariat then reviewed and assessed each declaration. In the case of a potential conflict of interest, the reason was presented to the GDG.

According to the policy of the WHO Office of Compliance, Risk Management and Ethics, the biographies of potential GDG members were posted on the internet for a minimum of 14 days before formal invitations were issued. Further guidance of this office, also adhered to, included undertaking a web search of all potential members to ensure identification of any possibly significant conflicts of interest.

The procedures for the management of declared conflicts of interests were undertaken in accordance with the WHO Guidelines for declaration of interests (WHO experts). When a conflict of interest was considered significant enough to pose a risk to the guideline development process or reduce its credibility, the experts were required to openly declare such a conflict at the beginning of the Technical Consultation. However, the declared conflicts were considered irrelevant on all occasions and did not warrant exclusion from the GDG. Therefore, all members participated fully in the formulation of the recommendations and no further action was taken.

The following interests were declared by GDG members:

Mary-Louise McLaws declared that Johnson & Johnson and Deb Australia provided a grant of 70 000 Australian dollars for the production of a video on hand hygiene in 2015. Deb also provided automated alcohol-based handrub dispensers for a study on hand hygiene in 2015. In 2014, Witheley Industries provided 10 000 Australian dollars for the bursary of a student conducting research on hand hygiene. In 2012, Gojo provided about 10 000 Australian dollars for laboratory testing used for a research study.

Petra Gastmeier, Director of the Institute of Hygiene and Environmental Medicine (Berlin) declared that her institution received financial contributions from companies producing alcohol-based handrubs (Bode, Schülke, Ecolab, B.Braun, Lysoform, Antiseptica, Dr. Schumacher, and Dr. Weigert) to support the German national hand hygiene campaign (approximately € 60 000 between 2014 and 2015).

Val Robertson declared that she received a research grant of 3000 US dollars from the International Federation of Infection Control in 2015 and that she currently receives a monthly honorarium of 2241 US dollars as a technical advisor to the Zimbabwe Infection Prevention and Control Project.

Alison Holmes declared to be a member of several scientific committees and advisory boards and to be the principal investigator for a number of projects for which her unit receives funds (see Annex V).

Introduction

Health care-associated infections (HAI) are one of the most common adverse events in care delivery and a major public health problem with an impact on morbidity, mortality and quality of life. At any one time, up to 7% of patients in developed and 10% in developing countries will acquire at least one HAI. These infections also present a significant economic burden at the societal level. However, a large percentage of HAI are preventable through effective infection prevention and control (IPC) measures.

Rationale for the guidelines

Since the publication of the World Health Organization (WHO) *Core components for infection prevention and control in 2009 (1)*, the threats posed by epidemics, pandemics and antimicrobial resistance (AMR) have become increasingly evident as ongoing universal challenges and they are now recognized as a top priority for action on the global health agenda. Effective IPC is the cornerstone of such action. The International Health Regulations (IHR) position effective IPC as a key strategy for dealing with public health threats of international concern. More recently, the United Nations Sustainable Development Goals (SDG) highlighted the importance of IPC as a contributor to safe, effective high-quality health service delivery, in particular those related to water, sanitation and hygiene (WASH) and quality and universal health coverage.

These new guidelines on the core components of IPC programmes form a key part of WHO strategies to prevent current and future threats, strengthen health service resilience and help combat AMR. They are intended also to support countries in the development of their own national protocols for IPC and AMR action plans and to support health care facilities as they develop or strengthen their own approaches to IPC. This document supersedes the WHO *Core components for infection prevention and control (1)* issued in 2009.

Objectives

The objectives of the guidelines are:

- to provide evidence-based recommendations on the core components of IPC programmes that are required to be in place at the national and acute facility level to prevent HAI and to combat AMR through IPC good practices;

- to support countries and health care facilities to develop or strengthen IPC programmes and strategies through the provision of evidence- and consensus-based guidance that can be adapted to the local context, while taking account of available resources and public health needs.

Target audience

These guidelines are intended to support IPC improvement at the national and facility level, both in public services and private sector. At the national level, this document provides guidance primarily to policy-makers responsible for the establishment and monitoring of national IPC programmes and the delivery of AMR national action plans within ministries of health. At the facility level, the main target audience is facility-level administrators (for example, chief executive officers) and those in charge of planning, developing and implementing local IPC programmes.

They are also relevant for national and facility safety and quality leads and managers, regulatory bodies and allied organizations, including academia, national IPC professional bodies, nongovernmental organizations involved in IPC activity and civil society groups. The document is of additional relevance to national and facility level WASH leads in all countries. It is important to note that although the guidelines focus on acute health care facilities, the expert panel believes that the core principles and practices of IPC as a countermeasure to the development of HAI are common to any facility where health care is delivered. Therefore, these guidelines should be considered also with some adaptations by community, primary care and long-term care facilities as they develop and review their IPC programmes.

While legal, policy and regulatory contexts may vary, these guidelines are relevant to both high- and low-resource settings.

Methods

These guidelines were developed following the methods outlined in the 2014 WHO *Handbook for guideline development*. The development process included six main stages: (1) identification of the primary outcomes and formulation of the PICO (Population/Participants, Intervention, Comparator, Outcome/s) question (an approach commonly used to formulate research questions); (2) performing two systematic

reviews for the retrieval of the evidence using a standardized methodology; (3) developing an inventory of national and regional IPC action plans and strategic documents; (4) assessment and synthesis of the evidence; (5) formulation of recommendations and good practice statements in an expert meeting; and (6) writing of the guidelines and planning for the dissemination and implementation strategies.

The development of the guidelines involved the formation of four main groups to guide the process: the WHO Guideline Steering Group, the Guidelines Development Group (GDG), the Systematic Reviews Expert Group and the External Peer Review Group. The WHO Steering Group identified the primary critical outcomes and topics, formulated the research questions and identified the systematic review teams, the guideline methodologist and members of the GDG. The GDG included international experts in IPC and infectious diseases, public health, researchers and patient representatives, as well as country delegates and stakeholders from the six WHO regions.

The first source of evidence was a review published by the “Systematic review and evidence-based guidance on organization of hospital infection control programmes” (SIGHT) group (2) and sponsored by the European Centre for Disease Prevention and Control. This review extended from 1996 to 2012 and identified 10 key components of IPC programmes at the facility level. This review was updated to include literature published up to 23 November 2015. An additional systematic review (2000-2015) with the same objectives was performed, but with a focus on the national level. Furthermore, an inventory report of existing national and regional strategic documents and action plans was developed by WHO, based on the repository of a previous survey and an online survey.

In the earlier review done by the SIGHT group, the quality of the evidence was assessed using the Integrated quality Criteria for Review of Multiple Study designs (ICROMS) scoring system. The SIGHT review update and the review focusing on the national level used the risk of bias criteria developed for the Cochrane Effective Practice and Organization of Care (EPOC) reviews. Based on the systematic reviews, the GDG formulated recommendations using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. For some topics, good practice statements were developed instead of recommendations in the absence of methodologically sound, direct evidence on the effectiveness of interventions. Finally, research implications were also identified by the GDG.

Recommendations

The eight components of IPC programmes published by the WHO expert group in 2009 and the 10 key components identified through the SIGHT review provided an initial foundation for the development of the recommendations. The GDG evaluated the relevance of these components along with the evidence emerging from the new systematic reviews and identified eight core components of IPC programmes, six of which apply to both the national and facility level, whereas two are more relevant for the facility level. While identifying the core components, the GDG formulated 11 recommendations and three good practice statements. Good practice statements are appropriate in situations where a large and compelling body of indirect evidence (non-EPOC studies) strongly supports the net benefit of the recommended actions and highlights important components of IPC programmes are deemed essential for IPC implementation according to GDG consensus. The recommendations and good practice statements are summarized in Table 1.

It is essential to note that the numbered list of core components of IPC programmes included in these guidelines is by no means intended to be a ranking order of the importance of each component. All core components should be considered equally important and crucial for the establishment and effective functioning of IPC programmes and practices. As countries and facilities implement the core components (or undertake action to review and strengthen their existing IPC programmes), they may decide to prioritize specific components depending on the context, previous achievements and identified gaps, with the long-term aim of building a comprehensive approach as detailed across all eight core components.

Guideline implementation

The successful implementation of the recommendations and good practice statements is dependent on a robust implementation strategy and a defined and appropriate process of adaptation and integration into relevant regional, national and facility level strategies. Implementation effectiveness will be influenced by existing health systems in each country, including available resources and the existing capacity and policies. The support of key stakeholders, partner agencies and organizations is also critical.

A separate resource to accompany the guidelines will be dedicated to strategies for their implementation at the national and facility level, including guidance on how to prioritize and implement the IPC core components in settings with limited resources. In addition, a comprehensive range of new IPC training packages will be produced in line with the core components’ principles and IPC good practices.

Table 1: Summary of IPC core components and key remarks

Core component	Recommendation or good practice statement	Key remarks	Strength of recommendation and quality of evidence
1. IPC programmes	<p>1a. Health care facility level</p> <p>The panel recommends that an IPC programme with a dedicated, trained team should be in place in each acute health care facility for the purpose of preventing HAI and combating AMR through IPC good practices.</p>	<ul style="list-style-type: none"> • The organization of IPC programmes must have clearly defined objectives based on local epidemiology and priorities according to risk assessment and functions that align with and contribute to the prevention of HAI and the spread of AMR in health care. • It is critical for a functioning IPC programme to have dedicated, trained professionals in every acute care facility. A minimum ratio of one full-time or equivalent infection preventionist (nurse or doctor) per 250 beds should be available. However, there was a strong opinion that a higher ratio should be considered, for example, one infection preventionist per 100 beds, due to increasing patient acuity and complexity, as well as the multiple roles and responsibilities of the modern preventionist. • Good quality microbiological laboratory support is a very critical factor an effective IPC programme. 	<p>Strong, very low quality</p>
	<p>1b. National level</p> <p>Active, stand-alone, national IPC programmes with clearly defined objectives, functions and activities should be established for the purpose of preventing HAI and combating AMR through IPC good practices. National IPC programmes should be linked with other relevant national programmes and professional organizations.</p>	<ul style="list-style-type: none"> • The organization of national IPC programmes must be established with clear objectives, functions, appointed infection preventionists and a defined scope of responsibilities. Minimum objectives should include: <ul style="list-style-type: none"> › goals to be achieved for endemic and epidemic infections › development of recommendations for IPC processes and practices that are known to be effective in preventing HAI and the spread of AMR • The IHR (2005) and the WHO Global Action Plan on AMR (2015) support national level action on IPC as a central part of health systems' capacity building and preparedness. This includes the development of national plans for preventing HAI, the development or strengthening of national policies and standards of practice regarding IPC activities in health facilities, and the associated monitoring of the implementation of and adherence to these national policies and standards. • The organization of the programme should include (but not be limited to) at least the following components: <ul style="list-style-type: none"> › appointed technical team of trained infection preventionists, including medical and nursing professionals › the technical teams should have formal IPC training and allocated time according to tasks › the team should have the authority to make decisions and to influence field implementation › the team should have a protected and dedicated budget according to planned IPC activity and support by national authorities and leaders › The linkages between the national IPC programme and other related programmes are key and should be established and maintained. › An official multidisciplinary group, committee or an equivalent structure should be established to interact with the IPC technical team. 	<p>Good practice statement</p>

Core component	Recommendation or good practice statement	Key remarks	Strength of recommendation and quality of evidence
2. IPC guidelines	<p>The panel recommends that evidence-based guidelines should be developed and implemented for the purpose of reducing HAI and AMR. The education and training of relevant health care workers on the guideline recommendations and the monitoring of adherence with guideline recommendations should be undertaken to achieve successful implementation</p>	<p>Health care facility</p> <ul style="list-style-type: none"> • Appropriate IPC expertise is necessary to write or adapt and adopt a guideline both at the national and health care facility level. Guidelines should be evidence-based and reference international or national standards. Adaptation to local conditions should be considered for the most effective uptake and implementation. • Monitoring adherence to guideline implementation is essential. <p>National level</p> <ul style="list-style-type: none"> • Developing relevant evidence-based national IPC guidelines and related implementation strategies is one of the key functions of the national IPC programme. • The national IPC programme should also ensure that the necessary infrastructures and supplies to enable guideline implementation are in place. • The national IPC programme should support and mandate health care workers' education and training focused on the guideline recommendations. 	<p>Strong, very low quality</p>
3. IPC education and training	<p>3a. Health care facility level</p> <p>The panel recommends that IPC education should be in place for all health care workers by utilizing team- and task-based strategies that are participatory and include bedside and simulation training to reduce the risk of HAI and AMR.</p>	<ul style="list-style-type: none"> • IPC education and training should be a part of an overall health facility education strategy, including new employee orientation and the provision of continuous educational opportunities for existing staff, regardless of level and position (for example, including also senior administrative and housekeeping staff). • Three categories of human resources were identified as targets for IPC training and requiring different strategies and training contents: IPC specialists, all health care workers involved in service delivery and patient care, and other personnel that support health service delivery (administrative and managerial staff, auxiliary service staff, cleaners, etc.). • Periodic evaluations of both the effectiveness of training programmes and assessment of staff knowledge should be undertaken on a routine basis. 	<p>Strong, moderate quality</p>
	<p>3b. National level</p> <p>The national IPC programme should support the education and training of the health workforce as one of its core functions.</p>	<ul style="list-style-type: none"> • The IPC national team plays a key role to support and make IPC training happen at the facility level. • To support the development and maintenance of a skilled, knowledgeable health workforce, national pregraduate and postgraduate IPC curricula should be developed in collaboration with local academic institutions. • In the curricula development process, it is advisable to refer to international curricula and networks for specialized IPC programmes and to adapt these documents and approaches to national needs and local available resources. • The national IPC programme should provide guidance and recommendations for in-service training to be rolled out at the facility level according to detailed IPC core competencies for health care workers and covering all professional categories listed in core component 3a. 	<p>Good practice statement</p>

Core component	Recommendation or good practice statement	Key remarks	Strength of recommendation and quality of evidence
4. Surveillance	<p>4a. Health care facility level</p> <p>The panel recommends that facility-based HAI surveillance should be performed to guide IPC interventions and detect outbreaks, including AMR surveillance with timely feedback of results to health care workers and stakeholders and through national networks.</p>	<ul style="list-style-type: none"> • Surveillance of HAI is critical to inform and guide IPC strategies. • Health care facility surveillance should be based on national recommendations and standard definitions and customized to the facility according to available resources with clear objectives and strategies. Surveillance should provide information for: <ul style="list-style-type: none"> › describing the status of infections associated with health care (that is, incidence and/or prevalence, type, aetiology and, ideally, data on severity and the attributable burden of disease); › identification of the most relevant AMR patterns; › identification of high risk populations, procedures and exposures; › existence and functioning of WASH infrastructures, such as a water supply, toilets and health care waste disposal; › early detection of clusters and outbreaks (that is, early warning system); › evaluation of the impact of interventions. • Quality microbiology and laboratory capacity is essential to enable reliable HAI surveillance. • The responsibility for planning and conducting surveillance and analysing, interpreting and disseminating the collected data remains usually with the IPC committee and the IPC team. • Methods for detecting infections should be active. Different surveillance strategies could include the use of prevalence or incidence studies. • Hospital-based infection surveillance systems should be linked to integrated public health infection surveillance systems. • Surveillance reports should be disseminated in a timely manner to those at the managerial or administration level (decision-makers) and the unit/ward level (frontline health care workers). • A system for surveillance data quality assessment is of the utmost importance. 	Strong, very low quality
	<p>4b. National level</p> <p>The panel recommends that national HAI surveillance programmes and networks that include mechanisms for timely data feedback and with the potential to be used for benchmarking purposes should be established to reduce HAI and AMR.</p>	<ul style="list-style-type: none"> • National HAI surveillance systems feed in to general public health capacity building and the strengthening of essential public health functions. National surveillance programmes are also crucial for the early detection of some outbreaks in which cases are described by the identification of the pathogen concerned or a distinct AMR pattern. Furthermore, national microbiological data about HAI aetiology and resistance patterns also provide information relevant for policies on the use of antimicrobials and other AMR-related strategies and interventions. • Establishing a national HAI surveillance programme requires full support and engagement by governments and other respective authorities and the allocation of human and financial resources. • National surveillance should have clear objectives, a standardized set of case definitions, methods for detecting infections (numerators) and the exposed population (denominators), a process for the analysis of data and reports and a method for evaluating the quality of the data. 	Strong, very low quality

Core component	Recommendation or good practice statement	Key remarks	Strength of recommendation and quality of evidence
		<ul style="list-style-type: none"> • Clear regular reporting lines of HAI surveillance data from the local facility to the national level should be established. • International guidelines on HAI definitions are important, but it is the adaptation at country level that is critical for implementation. • Microbiology and laboratory capacity and quality are critical for national and hospital-based HAI and AMR surveillance. Standardized definitions and laboratory methods should be adopted. • Good quality microbiological support provided by at least one national reference laboratory is a critical factor for an effective national IPC surveillance programme. • A national training programme for performing surveillance should be established to ensure the appropriate and consistent application of national surveillance guidelines and corresponding implementation toolkits. • Surveillance data is needed to guide the development and implementation of effective control interventions. 	
5. Multimodal strategies	<p>5a. Health care facility level</p> <p>The panel recommends that IPC activities using multimodal strategies should be implemented to improve practices and reduce HAI and AMR.</p>	<ul style="list-style-type: none"> • Successful multimodal interventions should be associated with an overall organizational culture change as effective IPC can be a reflector of quality care, a positive organizational culture and an enhanced patient safety climate. • Successful multimodal strategies include the involvement of champions or role models in several cases. • Implementation of multimodal strategies within health care institutions needs to be linked with national quality aims and initiatives, including health care quality improvement initiatives or health facility accreditation bodies. 	Strong, low quality
	<p>5b. National level</p> <p>The panel recommends that national IPC programmes should coordinate and facilitate the implementation of IPC activities through multimodal strategies on a nationwide or subnational level.</p>	<ul style="list-style-type: none"> • The national approach to coordinating and supporting local (health facility level) multimodal interventions should be within the mandate of the national IPC programme and be considered within the context of other quality improvement programmes or health facility accreditation bodies. • Ministry of health support and the necessary resources, including policies, regulations and tools, are essential for effective central coordination. This recommendation is to support facility level improvement. • Successful multimodal interventions should be associated with overall cross-organizational culture change as effective IPC can be a reflector of quality care, a positive organizational culture and an enhanced patient safety climate. • Strong consideration should be given to country adaptation of implementation strategies reported in the literature, as well as to feedback of results to key stakeholders and education and training to all relevant persons involved in the implementation of the multimodal approach. 	Strong, low quality

Core component	Recommendation or good practice statement	Key remarks	Strength of recommendation and quality of evidence
6. Monitoring/ audit of IPC practices and feedback	<p>6a. Health care facility level</p> <p>The panel recommends that regular monitoring/ audit and timely feedback of health care practices according to IPC standards should be performed to prevent and control HAI and AMR at the health care facility level. Feedback should be provided to all audited persons and relevant staff.</p>	<ul style="list-style-type: none"> • The main purpose of auditing/monitoring practices and other indicators and feedback is to achieve behaviour change or other process modification to improve the quality of care and practice with the goal of reducing the risk of HAI and AMR spread. Monitoring and feedback are also aimed at engaging stakeholders, creating partnerships and developing working groups and networks. • Sharing the audit results and providing feedback not only with those being audited (individual change), but also with hospital management and senior administration (organizational change) are critical steps. IPC teams and committees (or quality of care committees) should also be included as IPC care practices are quality markers for these programmes. • IPC programmes should be periodically evaluated to assess the extent to which the objectives are met, the goals accomplished, whether the activities are being performed according to requirements and to identify aspects that may need improvement identified via standardized audits. Important information that may be used for this purpose includes the results of the assessment of compliance with IPC practices, other process indicators (for example, training activities), dedicated time by the IPC team and resource allocation. 	<p>Strong, low quality</p>
	<p>6b. National level</p> <p>The panel recommends that a national IPC monitoring and evaluation programme should be established to assess the extent to which standards are being met and activities are being performed according to the programme's goals and objectives. Hand hygiene monitoring with feedback should be considered as a key performance indicator at the national level.</p>	<ul style="list-style-type: none"> • Regular monitoring and evaluation provides a systematic method to document the progress and impact of national programmes in terms of defined indicators, for example, tracking hand hygiene improvement as a key indicator, including hand hygiene compliance monitoring. • National level monitoring and evaluation should have in place mechanisms that: <ul style="list-style-type: none"> › Provide regular reports on the state of the national goals (outcomes and processes) and strategies. › Regularly monitor and evaluate the WASH services, IPC activities and structure of the health care facilities through audits or other officially recognized means. › Promote the evaluation of the performance of local IPC programmes in a non- punitive institutional culture. 	<p>Strong, moderate quality</p>

Core component	Recommendation or good practice statement	Key remarks	Strength of recommendation and quality of evidence
<p>7. Workload, staffing and bed occupancy (acute health care facility only)</p>	<p>The panel recommends that the following elements should be adhered to in order to reduce the risk of HAI and the spread of AMR:</p> <p>(1) bed occupancy should not exceed the standard capacity of the facility;</p> <p>(2) health care worker staffing levels should be adequately assigned according to patient workload.</p>	<ul style="list-style-type: none"> Standards for bed occupancy should be one patient per bed with adequate spacing between patient beds and that this should not be exceeded. Intended capacity may vary from original designs and across facilities and countries. For these reasons, it was proposed that ward design regarding bed capacity should be adhered to and in accordance with standards. In exceptional circumstances where bed capacity is exceeded, hospital management should act to ensure appropriate staffing levels that meet patient demand and an adequate distance between beds. These principles apply to all units and departments with inpatient beds, including emergency departments. The WHO Workload Indicators of Staffing Need method provides health managers with a systematic way to determine how many health workers of a particular type are required to cope with the workload of a given health facility and decision-making (http://www.who.int/hrh/resources/wisn_user_manual/en). Overcrowding was recognized as being a public health issue that can lead to disease transmission. 	<p>Strong, very low quality</p>

Core component	Recommendation or good practice statement	Key remarks	Strength of recommendation and quality of evidence
8. Built environment, materials and equipment for IPC at the facility level (acute health care facility only)	8a. Patient care activities should be undertaken in a clean and/or hygienic environment that facilitates practices related to the prevention and control of HAI, as well as AMR, including all elements around the WASH infrastructure and services and the availability of appropriate IPC materials and equipment.	<ul style="list-style-type: none"> • An appropriate environment, WASH services and materials and equipment for IPC are a core component of effective IPC programmes at health care facilities. • Ensuring an adequate hygienic environment is the responsibility of senior facility managers and local authorities. However, the central government and national IPC and WASH programmes also play an important role in developing standards and recommending their implementation regarding adequate WASH services in health care facilities, the hygienic environment, and the availability of IPC materials and equipment at the point of care. • WHO standards for drinking water quality, sanitation and environmental health in health care facilities should be implemented. 	Good practice statement
	8b. The panel recommends that materials and equipment to perform appropriate hand hygiene should be readily available at the point of care.	<ul style="list-style-type: none"> • WHO standards for the adequate number and appropriate position of hand hygiene facilities should be implemented in all health care facilities. 	Strong, very low quality

HAI: health care-associated infection; AMR: antimicrobial resistance; IPC: infection prevention and control; IHR: International Health Regulations; WASH: water, sanitation and health; NA: not applicable.

1 Background

Health care-associated infections (HAI) are one of the most common adverse events in care delivery and both the endemic burden and the occurrence of epidemics are a major public health problem. 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 HAI are preventable and there is a growing body of evidence to help raise awareness of the global burden of harm caused by these infections (3, 4), including strategies to reduce their spread (5).

Infection prevention and control (IPC) is a universally relevant component of all health systems and affects the health and safety of both people who use services and those who provide them. Driven by a number of emerging factors in the field of global public health, there is a need to support Member States in the development and strengthening of IPC capacity to achieve resilient health systems, both at the national and facility levels. These factors are closely related to the aftermath of recent global public health emergencies of international concern, such as the 2013-2015 Ebola virus disease outbreak and the current review of the International Health Regulations (IHR), together with the World Health Organization (WHO) action agenda for antimicrobial resistance (AMR) and its lead role in implementing the associated Global Action Plan.

There is a worldwide consensus that urgent action is needed by all Member States to mitigate future epidemics and pandemics and prevent and control the spread of antimicrobial-resistant microorganisms. In addition, a strengthened capacity in relation to IPC at both national and local levels will contribute to the fulfilment of strategic goal 5 of the new WHO global strategy on integrated people-centred health services and the United Nations Sustainable Development Goals (SDG), particularly those related to universal access to water, sanitation and hygiene (WASH), quality health service delivery in the context of universal health coverage and the reduction of neonatal and maternal mortality.

With the exception of a WHO expert meeting report (1) issued in 2009, there remains a major gap in international evidence-based recommendations as to what should constitute the core components of IPC programmes at the national and facility level. The proposed work builds on the initial momentum of the 2009 WHO report and subsequent requests for support for national capacity building from Member States. In particular, requests from countries in the West African sub-region that were severely affected by the Ebola outbreak identified IPC as one of the top priorities for both patients and staff. Furthermore, WHO guidance to identify the core components of IPC programmes is essential to allow countries to develop national action plans for combating AMR and the associated reporting to the World Health Assembly in 2017 on this topic. In this context, these guidelines have widespread support from WHO regional focal points for IPC, AMR and patient safety and quality.

2 Scope and objectives

2.1 Target audience

The core components of IPC programmes at the national and acute health care facility level have the potential to facilitate evidence-based decision-making. The main target audiences of the document can be separated according to the national and facility level, although there is a clear overlap.

At the national level, the document is targeted primarily at policy-makers responsible for the establishment and monitoring of national IPC programmes and the delivery of AMR national action plans within ministries of health. In particular, this document is relevant for staff at ministries of health, health service departments, or those in charge of health facility accreditation/regulation, health care quality improvement, public health, disease control, water and sanitation, occupational health and antimicrobial stewardship programmes.

At the facility level, the main target audience is acute health care facility-level administrators tasked with the same remit (for example, chief executive officers).

The core components will support the implementation of national and local IPC programmes by their relevance to national and facility IPC leaders, safety and quality leads and managers, local teams and regulatory bodies.

It is important to note that although the recommendations for the facility level focus on acute health care facilities, the expert panel believes that the core principles and practices of IPC as a countermeasure to the development of HAI are common to any facility where health care is delivered. Therefore, these guidelines should be considered also with some adaptations by community, primary care and long-term care facilities as they develop and review their IPC programmes.

Allied organizations will also have an interest in the core components, including academia, national IPC professional bodies, nongovernmental organizations involved in IPC activity and civil society groups. Given the close interrelationship between WASH and IPC, the document is of additional relevance to national and facility level WASH leads in all countries. While legal, policy and regulatory contexts may vary, these guidelines are relevant to both high- and low-resource settings as the need for effective IPC programmes is universal across different cultures and contexts.

Finally, the core components of IPC programmes should be implemented not only in the public health care system, but also in private health care facilities. National health authorities should ensure that senior managers of private health care facilities and related networks or umbrella organizations are aware of these guidelines.

2.2 Objectives and scope of the guidelines

The primary objective of these guidelines is to provide evidence- and expert consensus- based recommendations on the core components of IPC programmes that are required to be in place at the national and facility level to prevent HAI and to combat AMR through IPC good practices. They are intended to provide a feasible, effective and acceptable framework for the development or strengthening of IPC programmes. The recommendations can be adapted to the local context based on information collected ahead of implementation and thus influenced by available resources and public health needs.

The eight components of IPC programmes published by the WHO expert group in 2009 and the 10 key components identified through the SIGHT review provided an initial foundation for the development of the recommendations. The GDG evaluated the relevance of these components along with the evidence emerging from the systematic reviews and developed the core components listed in these guidelines. Most of the new core components actually coincide with the ones identified previously.

It is essential to note that the numbered list of core components of IPC programmes included in these guidelines are by no means intended to be a ranking order of the *importance* of each component. All core components should be considered equally important and essential for the establishment and effective functioning of IPC programmes and practices. As countries and facilities implement the core components (or undertake action to review and strengthen their existing IPC programmes), they may decide to prioritize specific components depending on the context, previous achievements and identified gaps, with the long-term aim of building a comprehensive approach, as detailed across all eight core components.

3 Guiding principles

The recommendations outlined in this document are underpinned by a number of guiding principles:

- IPC implementation is relevant to health system strengthening.
- The availability of guidelines related to what constitutes the core components of IPC programmes at the national and facility level enhances the capacity of Member States to develop and implement effective technical and behaviour-modifying interventions. In turn, these will have a direct impact on the burden of HAI and AMR, including outbreaks of highly transmissible diseases, which differ from other control measures and where it can be seen rapidly if implementation is effective.
- Access to health care services designed and managed to minimize the risks of avoidable HAI for patients and health care workers is a basic human right.
- Effective and integrated IPC is a public health issue and contributes in a significant way to strengthening core capacities and health service resilience within the context of the IHR.
- The prevention and control of HAI is a significant contributor to the achievement of the United Nations health-related SDGs.
- Effective IPC is a key determinant of the quality of health service delivery to achieve people-centred, integrated universal health coverage.

Adherence to the core components of IPC programmes described within this guideline can be considered as a mechanism to apply these guiding principles.

4 Methods

4.1 WHO guidelines development process

The guidelines were developed according to the requirements described in the WHO *Handbook for guideline development* (6) and according to a scoping proposal approved by the WHO Guidelines Review Committee.

The development process included six main stages: (1) identification of the primary outcomes and formulation of the PICO (Population/Participants, Intervention, Comparator, Outcomes) question, an approach commonly used to formulate research questions; (2) the conduct of 2 systematic reviews for the retrieval of the evidence using a standardized methodology; (3) development of an inventory of national and regional IPC action plans and strategic documents; (4) assessment and synthesis of the evidence; (5) formulation of recommendations and good practice statements in an expert meeting; and (6) writing of the guidelines and planning for the dissemination and implementation strategies.

The development process also included the participation of four main groups that helped guide and greatly contributed to the overall process. The roles and functions are described herein.

4.2 WHO Guideline Steering Group

The WHO Guideline Steering Group was chaired by the director of the Department of Service Delivery and Safety (SDS). Participating members were from the SDS IPC Global unit, the SDS Quality and Universal Health Coverage programme, the People-Centred and Integrated Health Services team, the Department of Pandemic and Epidemic Diseases, the WASH team, and the IPC focal points at the WHO Regional Office for the Americas and the Regional Office for the Eastern Mediterranean.

The Steering Group drafted the initial scoping document for the development of the guidelines, identified the primary critical outcomes and topics and formulated the research questions. The Group identified systematic review teams, the guideline methodologist, the members of the Guideline Development Group (GDG) and the external peer reviewers. The chair and the SDS IPC team supervised the evidence

retrieval, syntheses and analysis, organized the GDG meetings, prepared or reviewed the final guideline document, managed the external peer reviewers' comments and the guideline publication and dissemination. The members of the WHO Steering Group are presented in the Acknowledgements.

4.3 Guidelines Development Group

The WHO Guideline Steering Group identified 27 external experts, country delegates and stakeholders from the six WHO regions to constitute the GDG. This was a diverse group representing various professional and stakeholder groups, such as IPC, public health and infectious diseases specialists, researchers and patient representatives. Geographical representation and gender balance were also considerations when selecting GDG members. Members of this group appraised the evidence that was used to inform the recommendations, advised on the interpretation of the evidence, formulated the final recommendations and good practice statements, taking into consideration the previous WHO 2009 document on IPC core components, and reviewed and approved the final guideline document. The GDG members are presented in the Acknowledgements.

4.4 External Peer Review Group

The Group included six technical experts with high-level knowledge and experience in IPC, patient safety and health management, including field implementation. The Group was geographically balanced to ensure views from both high- and low-/middle-income countries (LMICs); no member declared a conflict of interest. The primary focus was to review the final guideline document and identify any inaccuracies or errors and comment on technical content and evidence, clarity of language, contextual issues and implications for implementation. The External Peer Review Group ensured that the guideline decision-making processes incorporated values and preferences of end-users, including health care professionals and policy-makers. It was not within the remit of this group to change the recommendations formulated by the GDG. However, all reviewers agreed with each recommendation and some suggested a few useful editorial changes. The members of the WHO External Review Peer Group are presented in the Acknowledgements.

4.5 Research question/PICO

The specific PICO questions were developed by the WHO secretariat based on the original work by Zingg and colleagues (2). The main research question underlying this work was:

- What are the core components of effective IPC programmes aimed at reducing HAIs at the national and health facility levels?

The interventions were categorized according to a list of dimensions that were five for the already available SIGHT systematic review (see Table 4.1, section 4.6.1) and expanded to nine for its update and the additional review at the national level (see Table 4.2, section 4.6.1). For each intervention, the PICO question was formulated as follows:

Population: patients of any age admitted to an acute health care facility or a specific ward or front-line health care workers (depending on the intervention and outcome).

Intervention: each of the IPC interventions listed in Table 4.2 in section 4.6.1 implemented either at the national or acute health care facility or ward level.

Comparator: regular care practices with no specific IPC intervention.

Outcome: The incidence or prevalence of HAIs (including those caused by antimicrobial-resistant microorganisms), including other secondary outcomes (for example, hand hygiene compliance, alcohol-based handrub consumption, health care workers' knowledge).

More details can be found in the web Appendices I and II.

4.6 Evidence identification and retrieval

According to the guidelines development plan approved by the WHO Guidelines Review Committee, the first source of evidence was a review published by the "Systematic review and evidence-based guidance on organization of hospital infection control programmes" (SIGHT) group (2) and sponsored by the European Centre for Disease Prevention and Control. This review extended from 1996 to 2012 and identified 10 key components of IPC programmes at the facility level. In addition, this review was updated by the WHO IPC Global Unit between November 2015 and March 2016. In the same period, another systematic review with the same objectives was commissioned to the Safeguarding Health through Infection Prevention research group of the Glasgow Caledonian University (United Kingdom), but with a focus on the national level. Furthermore, an inventory report of existing national and regional strategic documents and action plans was developed by the WHO IPC Global Unit team based on the repository of a previous survey and an online survey.

4.6.1 Systematic review: facility level

The SIGHT review and its update were used to evaluate the evidence on the effectiveness of key components of IPC programmes at the facility level.

In summary, the SIGHT review (2) was reported according to the PRISMA guidelines (7) by 3 participating institutions (University of Geneva Hospitals, Switzerland; Imperial College London, United Kingdom; and the University Hospital of Freiburg, Germany) (2).

The search was stratified according to 5 dimensions (Table 4.1). The following databases were searched for reports: Medline; the Cochrane Central Register of Controlled Trials (CENTRAL); the Excerpta Medica Database (EMBASE); the Outbreak Database; PsychINFO; and the Health Management Information Consortium database. The time limit included studies published between 1 January 1996 and 31 December 2012, including any landmark papers published before 1996. Studies in English, French, German, Italian, Portuguese and Spanish were eligible when an English title or abstract was available (2).

Table 4.1: SIGHT search stratified by dimension

Dimension no	Thematic area
1	Organizational and structural arrangements to implement IPC programmes
2	Targets and methods of HAI surveillance, outbreak management and the role of feedback
3	Methods and effectiveness of educating and training health care workers
4	Effectiveness of interventions on behavioural change and quality of care, particularly in the context of multimodal prevention strategies
5	Overview and effectiveness of local policies and resources for standard and transmission-based isolation precautions

SIGHT: Systematic review and evidence-based guidance on organization of hospital infection control programmes; IPC: infection prevention and control; HAI: health care-associated infections

The specific criteria for the inclusion and exclusion of literature for the SIGHT review can be found in the Appendix to the main publication (2).

Initial assessment was done by screening titles and abstracts against the inclusion/exclusion criteria. A second reviewer assessed one third of the titles and abstracts and 100% of the full texts; reports without abstracts were read in full.

Disagreements were resolved by consensus or by a third reviewer if agreement could not be reached (2).

The Integrated quality criteria for review of multiple study designs (ICROMS) scoring system developed for the SIGHT review (8) was used to assess the quality of articles. Two reviewers conducted the quality assessment of all studies. Disagreements were resolved by consensus and a third reviewer was consulted if agreement could not be reached. Based on the ICROMS summary score, the quality of studies was graded as 'low' (1), 'medium' (2) or 'high' (3) (2, 8).

An expert group was established to review the categorization and elements of key components that emerged from the systematic group. This group also checked each one for the validity of classification, assessed European Union-wide applicability and ease of implementation and defined the corresponding structural and process indicators. Overall evidence was graded as 'low' (1), 'intermediate' (2) or 'high' (3) on the basis of the median value for the studies contributing to the component (2).

An update of the SIGHT review was conducted between November 2015 and March 2016 by the WHO IPC Global Unit team using a very similar methodology to SIGHT for the search strategy and evidence review. The time limit included all studies published from 1 January 2013 to 23 November 2015. The following databases were searched according to the advice of the WHO librarian: Medline (via EBSCO); EMBASE (via Ovid); Cumulative Index to Nursing and Allied Health Literature (CINAHL); Cochrane Central Register of Controlled Trials (CENTRAL); the Outbreak Database; and the WHO Institutional Repository for Information Sharing. The search was stratified by 9 dimensions that were addressed separately (Table 4.2). Articles in at least English, French, Spanish and Portuguese were included when an English language title or abstract was available. A comprehensive list of search terms was used, including Medical Subject Headings.

Criteria for the inclusion and exclusion of literature for the review were based on the evidence needed and available to answer the research question. Search strategies and summaries of evidence for the systematic review are reported in web Appendix I.

Six primary reviewers screened the retrieved titles and abstracts against the inclusion/exclusion criteria according to the 9 dimensions (Table 4.2). All reports that had relevant titles, but no abstracts, were read in full. One third (30%)

of titles and abstracts in each dimension was screened by a secondary reviewer and disagreements resolved by consensus or by a third reviewer if no agreement could be achieved. A final decision for inclusion was made after full text review by the same six primary reviewers. A pre-defined data extraction form was used for all retained studies.

As recommended by the methodologist and accepted by the Guidelines Review Committee, the risk of bias of eligible studies was assessed according to the criteria developed by the Cochrane Effective Practice and Organization of Care (EPOC) group (9), rather than by the ICROMS scoring system used in the original SIGHT review. According to EPOC guidance, only randomized controlled trials (RCTs), non-RCTs, controlled before-after studies or interrupted time series studies were included in the quality assessment. Risk of bias assessments using the EPOC framework were conducted by two reviewers. Disagreements were resolved by consensus or consultation with the project's senior author and/or methodologist if no agreement could be reached. Studies not meeting the EPOC study design criteria ('non-EPOC studies') were not formally assessed and their quality was considered very low, but their results were also summarized and used in specific cases to support good practice statements or to complement the evidence background for recommendations.

Table 4.2: Dimensions and corresponding components used for the SIGHT review update

Dimension N°	Components	Description
1	Organization and structure of infection prevention and control programmes	Organizational and structural arrangements to implement infection prevention and control programmes, including access to qualified infection control professionals and management roles
2	Surveillance	Targets and methods of HAI surveillance, outbreak management and the role of feedback
3	Education and training	Methods and effectiveness of educating and training health care workers
4	Behaviour change strategies	Effectiveness of interventions on behavioural change and quality of care (that is, multimodal strategies)
5	Standard and transmission-based precautions	Overview and effectiveness of local policies and resources for standard and transmission-based isolation precautions
6	Auditing	The process of auditing and its impact on HAIs
7	Patient participation	Patient empowerment and involvement in the prevention of HAIs
8	Target setting	Setting targets or goals and the impact on HAI prevention
9	Knowledge management	A range of strategies to identify, create and distribute information and data within and outside of an institution

HAI: health care-associated infection

4.6.2 Systematic review: national level

The main research question for the review was to assess the effectiveness of predefined components of IPC programmes (Table 4.2) to reduce HAI and/or improve a number of IPC indicators when implemented at the national level. The period considered was 1 January 2000 to 31 December 2015. The following databases were searched: Medline (via EBSCO); EMBASE (via Ovid); CINAHL; Cochrane CENTRAL; and the WHO Institutional Repository for Information Sharing. Reference lists were searched manually to identify additional studies meeting the inclusion criteria. Regarding language restrictions, at least English, French and Spanish

were included when an English language title or abstract was available. A comprehensive list of search terms was used, including Medical Subject Headings.

Criteria for the inclusion and exclusion of literature for the reviews were based on the evidence needed and available to answer the research question. Search strategies, including specific summaries of evidence for each systematic review are reported in web Appendices I and II.

The titles and abstracts of papers identified from the literature search were screened against the eligibility criteria by three reviewers. A 10% subset of the papers screened by each reviewer was independently screened by another reviewer. A final decision on inclusion was then made in conjunction with two reviewers and through discussion with a third reviewer, when necessary. A structured review-specific data extraction form was used for all retained studies.

Individual studies were assessed for risk of bias by four reviewers using the EPOC risk of bias criteria (9) (web Appendix II). As defined by EPOC, only RCTs, non-RCTs, controlled before-after studies or interrupted time series were included in the quality assessment. Disagreements were resolved by consensus or consultation with the project's senior author and/or methodologist if no agreement could be reached. The quality of evidence was judged to have a high, low or unclear risk of bias according to the respective criteria corresponding to the type of study design.

4.6.3 Inventory of national and regional IPC action plans and strategic documents

A methodology and data capture approach was developed for the inventory to identify, record and analyse regional and national documents addressing the key components of IPC programmes. The approach covered all 6 WHO regions (African Region, Region of the Americas, Eastern Mediterranean Region, European Region, South-East Asia Region and the Western Pacific Region).

Starting in October 2015, the scope of the work was fully discussed and mapped out based on internal and external meetings with the WHO Department of Pandemic and Epidemic Diseases/AMR team, the Infection Control and Publications Unit and WHO regional focal points. The meetings examined IPC components either currently being implemented or stated as required across regions and countries in their efforts to reduce HAI and/or tackle AMR, as demonstrated by existing regional and national documents.

The WHO Department of Pandemic and Epidemic Diseases/AMR team provided a repository of AMR national action plans/strategies from its previous work, which allowed to form a solid starting point in sourcing documents.

WHO regional focal points were requested to provide input on existing documents from countries and regional offices. In addition, a short survey aimed at retrieving existing IPC national programmes and documents was set up via Datacol from 20 January to 13 May 2016 and regional focal points were asked to invite countries to participate.

All documents were reviewed in a two-stage approach: (1) a review of table of contents to target specific sections relevant to national and facility level IPC; and (2) an electronic keyword-finding approach to extract relevant information in Word or PDF files to avoid missing useful information. Criteria for the inclusion and exclusion of documents for the regional inventory were based on the evidence needed and available to answer the research question. Summaries of the inventory's findings are reported in web Appendix III.

A pre-defined evidence table was developed for the data capture of regional and national level documents addressing IPC at the national and facility level and based on 2 main documents: the WHO *Core components for infection prevention and control* (1) and the SIGHT review (2). The main fields within which data were captured relate to the 8 components listed in the 2008 meeting report. The components suggested in the SIGHT report are included within this table. Data extraction was performed by 3 primary reviewers. The information gathered through this inventory, in particular regarding existing gaps, was taken into consideration by experts during the discussion to define priorities and recommendations. It was also used to feed into the background sections of the chapters related to the core components.

Evaluation of the evidence and recommendations' development by the GDG

The results of the systematic reviews and regional inventory were presented at a GDG meeting held from 30 March to 1 April 2016 according to the PICO questions and the above-mentioned standardized methodology.

In all 3 reviews (SIGHT review, SIGHT review update, national level review), it was not possible to perform meta-analyses or a formal evaluation of the overall body of the evidence using the Grading of Recommendations Assessment Development (GRADE) system, particularly in terms of the degree of

precision of effect estimates, their consistency, and the directness or applicability of summary estimates or the risk of publication bias (10, 11). This was due to a wide range of outcomes assessed and a large degree of heterogeneity in study designs and methods used in the included studies.

However, the quality or risk of bias of individual studies was assessed using the ICROMS scale or the EPOC criteria as described above. The quality of relevant studies was rated as 'high', 'moderate', 'low', or 'very low'. Recommendations were then formulated by the GDG based on the quality of the evidence of the studies, the balance between benefits and harms, values and preferences, resource implications and acceptability and feasibility. These were assessed through discussion among members of the GDG.

The strength of recommendations was rated as either 'strong' (the panel was confident that the benefits of the intervention outweighed the risks) or 'conditional' (the panel considered that the benefits of the intervention probably outweighed the risks). The methodologist provided guidance to the GDG on formulating the wording and strength of the recommendations. Full consensus was achieved for the text and strength of each recommendation and good practice statement, except for the recommendation related to core component 4b (page 48), which was considered to be 'strong' by most GDG members. However, three members considered it to be 'conditional', while one abstained. Areas and topics requiring further research were also identified.

In the absence of methodologically sound, direct evidence on the effectiveness of interventions, the GDG decided to develop good practice statements under the guidance of the methodologist to highlight important components that were deemed essential for IPC implementation (12). Good practice statements are appropriate in situations where a large and compelling body of indirect evidence (non-EPOC studies) strongly supports the net benefit of the recommended action (13).

The draft chapters of the guidelines containing the details of the core components and recommendations were then prepared by the IPC Global Unit team and circulated to the GDG members for final approval and/or comments. All relevant suggested changes and edits were incorporated in a second draft. The second draft was then edited and circulated to external peer reviewers and the draft document was revised to address all relevant comments.

5 Important issues in infection prevention and control

The IHR give significant weight to IPC as a central strategy for dealing with public health threats of international concern (14). Such strategies have been tested in recent times based on infectious diseases, such as the Severe Acute Respiratory Syndrome and the Middle East respiratory syndrome. The recent Ebola virus disease outbreak in West Africa also demonstrated the key role of IPC strategies.

Driven by a number of contextual and emerging factors in the field of global public health, there is a need to support Member States in the development and strengthening of IPC capacity in the context of resilient health systems. These factors are closely related to the aftermath of the recent global public health emergency of international concern (Ebola virus disease outbreak of 2014) and the review of the IHR, together with the implementation of the Global Action Plan reflected in AMR national action plans. There is a global consensus that urgent action is required by all Member States to mitigate future epidemics and pandemics and stem the spread of AMR.

Four important issues relevant to the need to strengthen national and facility level IPC are addressed here:

- **Contributing to the post-Ebola country capacity-building agenda**

Triggered by the outbreak of Ebola virus disease, LMICs (and indeed all Member States) have been stimulated to review their national and local approaches to IPC and WASH in health care facilities in the context of patient and health care worker safety. As part of its normative role in the setting of standards and the provision of technical support and institutional capacity-building, the new WHO IPC Global Unit has identified a gap in the existence of evidence-based frameworks to support IPC country capacity-building.

- **Strengthening implementation of the IHR**

The IHR issued in 2005 came into force in June 2007. The IHR require Member States to notify WHO of events

that may constitute a public health emergency of international concern and outline the importance of IPC practices at the health care facility level for the purposes of containment following such events. The current monitoring and assessment tool for IHR core capacity (15) strongly features IPC, specifically mentioned as one of 20 indicators: "IPC is established and functioning at national and hospital levels" (16). IHR monitoring and evaluation is currently under review and IPC is anticipated to feature strongly in the new approach.

- **Supporting implementation of the Global Action Plan on AMR**

At the Sixty-eighth World Health Assembly in 2015, a global action plan was endorsed to tackle AMR. The draft Global Action Plan stipulates the development of national action plans with a deadline of 2017 for all Member States. IPC is singled out as one of the 5 strategic objectives to be reflected within all action plans.

- **Importance of core components for IPC programmes as a fundamental element of safe, high quality, people-centred and integrated care**

IPC is relevant to all health systems and affects the health outcome of patients and health care workers. Strengthened capacity in relation to IPC at both the national and local level is relevant to the pursuit of integrated, high-quality and people-centred health services (17) and the progression towards universal health coverage. In this context, IPC good practices also contribute to achieving the United Nations SDGs related to children and women's health (3.1, 3.2; <http://www.who.int/topics/sustainable-development-goals/targets/en/>).

HAI is a systems problem as it is both influenced by and impacts on the 6 building blocks of health systems (18), particularly those related to service delivery. Health care systems are often complex, but strategies to prevent HAI exist and must embrace issues of structure and WASH services, governance, accountability and human factors. Health care workers need to function within a system that supports the implementation of the right interventions at the right time to maintain patient safety and, at the same time, be accountable for the performance of their own safe and competent practices.

6 The burden of health care-associated infection

There is a growing body of evidence on the global burden of harm caused by HAI, as well as the strategies necessary for its reduction (4). In 2011, WHO reported that (3):

- on average at any given time 7% of patients in developed and 10% in developing countries will acquire at least one HAI;
- death from HAI occurs in about 10% of affected patients;
- European estimates showed that more than 4 million patients are affected by approximately 4.5 million episodes of HAI annually, leading to 16 million extra days of hospital stay, 37 000 attributable deaths and contributing to an additional 110 000;
- in the United States of America (USA), it was estimated that around 1.7 million patients are affected by HAI each year, representing a prevalence of 4.5% and accounting for 99 000 deaths.

Limited data are available from LMICs, but the prevalence of HAI is estimated to be between 5.7% and 19.1%. The increased burden of HAI in LMICs affects especially high-risk populations, such as patients admitted to intensive care units (ICUs) and neonates, with HAI frequency several-fold higher than in high-income countries, notably for device-associated infections. For example, the proportion of patients with an ICU-acquired infection can be as high as one in three in LMICs. Increased length of hospital stay associated with HAI in developing countries ranges between 5 and 29.5 days and excess mortality due to these infections in adult patients in Latin America, Asia and Africa were 18.5%, 23.6% and 29.3% for catheter-associated urinary tract infections, central line-associated bloodstream infections and ventilator-associated pneumonia, respectively (4). In this same analyses, the pooled SSI incidence was 11.8 per 100 patients undergoing surgical procedures (95% CI: 8.6–16.0) and 5.6 per 100 surgical procedures (95% CI: 2.9–10.5). SSI was the most frequent HAI reported hospital-wide in LMICs and the level of risk was significantly higher than in developed countries (4).

Four types of HAI (catheter-associated urinary tract infections, catheter-related bloodstream infection, surgical site infection

(SSI), ventilator-associated pneumonia) and interventions associated with their reduction/prevention have received the highest attention around the globe in relation to causes of patient harm and the recognized global burden of HAI.

Although the evidence is limited on the economic burden of HAI, particularly in LMICs, available data from the USA and Europe suggest a multi-billion dollar impact. According to the US Centers for Disease Control and Prevention, the overall, annual, direct medical costs of HAI to hospitals in the USA ranges from US\$ 35.7 to US\$ 45 billion (19), while the annual economic impact in Europe is as high as €7 billion (20).

HAI clearly presents a significant (and largely avoidable) economic impact at the patient and population level. This includes substantial extra costs to health services due to the increased length of hospital stay and the overall impact on the facility, as well as unnecessary investigations and treatment and additional time needed to perform patient care (21). Private costs to patients and informal carers relate to out-of-pocket expenditure and other quality of life related consequences (death, pain, discomfort, psychological trauma) and HAI is a well-known outcome measure in health-related quality of life research (22). Societal costs incurred include lost productivity due to morbidity and mortality.

It is important to note that current data on the global burden of harm caused by HAI does not address infections acquired by health care workers, data on outbreaks or data on bloodborne pathogens transmitted through transfusion, contaminated injections and other procedures. Combined with the acknowledged reporting gaps in existing surveillance systems, the burden of HAI is considered to be greatly underestimated.

Despite limitations in available knowledge, HAI is undoubtedly a common problem across developed and developing countries. Multiple factors are involved and include very limited WASH services in health care facilities in LMICs (23), the health care system and its organization, health care interventions, infrastructure and patient status. Significant progress has been made to reduce or eliminate HAI in many parts of the world. However, no country has successfully

eliminated the risk of acquisition completely. An additional concern is that populations in all countries are under threat from AMR as antimicrobials are the treatment of choice for infections. While the international call to action against AMR requires multifaceted intersectoral action, one element does include the prevention and management of HAI and this increasing global challenge has highlighted the importance of fundamental IPC measures when providing health care where acquired infections may not be treatable (24-26).

A recent WHO report produced in collaboration with Member States and other partners outlines the magnitude of AMR and the current state of surveillance globally (27). This survey found that few countries reported having comprehensive national AMR plans. In addition, national surveillance was hindered by poor laboratory capacity, infrastructure and data management challenges, widespread sales of antimicrobial medicines without prescriptions, lack of public awareness across all regions and an overall inadequate IPC approach (27).

High proportions of resistance to third-generation cephalosporins are reported for *Escherichia coli* and *Klebsiella pneumoniae*, thus increasing the demand for and use of carbapenems, the last resort to treat severe community- and hospital-acquired infections. For *K. pneumoniae*, proportions of resistance to carbapenems as high as 54% are reported in most countries. For *E. coli*, the high reported resistance to fluoroquinolones means limitations for available oral treatment, while high rates of methicillin-resistant *Staphylococcus aureus* (MRSA) place pressure on the use of second-line therapeutics to treat suspected or verified severe *S. aureus* infections, such as common skin and wound infections (27).

For these reasons, programmes to prevent the spread of AMR are essential. Despite the fundamental need of WASH for quality health service delivery, access to WASH in health care facilities is alarmingly poor. A 2015 WHO/UNICEF global report reveals that 38% of health care facilities have no water source. Water coverage estimates reduce by half when factors such as reliability and functionality are taken into consideration. Furthermore, the provision of soap and water or alcohol-based handrubs for hand hygiene was absent in over one third of facilities and almost one fifth of facilities did not have improved sanitation. Findings from the African Region highlight significant challenges (23).

In conclusion, the impact of HAI is significant. It presents a continued threat to the safe effective functioning of health systems and adversely impacts on the quality of health service delivery. It prolongs hospital stay, causes long-term disability, increases the likelihood of resistance of microorganisms to antimicrobials, incurs a massive additional financial burden for health systems, results in high financial and quality of life-related costs for patients and their families and leads to excess deaths. Based on available reports and the academic literature, it is clear that HAI is a global problem.

7 An overview of available relevant guidelines

Very few publications provide sound scientific data that can be used to determine which components are essential for IPC programmes in terms of effectiveness in reducing the risk of infection at the national or facility level. In recent years, a range of regional best practice or policy principles have been developed that address what could be considered as core components of IPC programmes at the national and/or facility level (2, 28-31). However, with the exception of the original 2009 WHO report (1), there remains a major gap in relation to the availability of international best practice principles for core components of national and facility level IPC programmes.

This document builds on the WHO *Core components for infection prevention and control programmes* issued in 2009, a report of the second meeting of the informal Network on Infection Prevention and Control in Health Care. This was the first example of expert consensus on core components of IPC programmes. Although this document has been used in several countries so far, it did not contain specific recommendations based on systematic reviews of the evidence and it did not undergo formal WHO guideline process development.

In addition to the 2009 WHO report, there are only a few non-evidence-based WHO guidance documents that are directly relevant to this work. These are:

- Infection control programmes to control antimicrobial resistance. Geneva: WHO; 2001
- Prevention of hospital-acquired infections. A practical guide, second edition. Geneva: WHO; 2002

A number of additional existing guidelines and relevant protocols include:

- WHO Essential environmental health standards in health care. Geneva: WHO; 2008 (32)
- WHO Global strategy for containment of antimicrobial resistance. Geneva: WHO; 2008 (33)
- Global action plan on antimicrobial resistance. Geneva: WHO; 2015 (34)
- International health regulations (2005), second edition. Geneva: WHO; 2008 (14)
- Strengthening health systems to improve health outcomes: WHO's framework for action. Geneva: WHO; 2007 (18)
- WHO Guidelines on hand hygiene in health care. Geneva: WHO; 2009 (35)
- Guide for developing national patient safety policy and strategic plan. Brazzaville: WHO Regional Office for Africa; 2014 (36)
- IHR core capacity monitoring framework: Checklist and indicators for monitoring progress in the development of IHR core capacities in States parties. Geneva; WHO; 2013 (16)

8 Core components

Core component 1: Infection prevention and control programmes

■ 1a. Health care facility level

RECOMMENDATION

The panel recommends that an IPC programme with a dedicated, trained team should be in place in each acute health care facility for the purpose of preventing HAI and combating AMR through IPC good practices.

(Strong recommendation, very low quality of evidence)

Rationale for the recommendation

- Evaluation of the evidence from two studies shows that IPC programmes including dedicated, trained professionals are effective in reducing HAI in acute care facilities. However, due to the different methodologies and the different outcomes measured, no meta-analysis was performed. Furthermore, the GDG noted that in one of the two studies, the IPC programme was focused on one pathogen only and limited to one hospital and thus its relevance might be questionable. Despite the limited published evidence and its very low quality, the GDG unanimously recommended that an IPC programme should be in place in all acute health care facilities and that the strength of this recommendation should be strong. This decision was based on the large effect of HAI reduction reported in the two studies and on the panel's conviction that the existence of an IPC programme is the necessary premise for any IPC action.

Remarks

- The content of section 1a is strongly linked to section 1b, thus providing a good practice statement and details about the organization of a national IPC programme. The national and health care facility programmes should be closely connected and work in synergy.
- The organization of IPC programmes must have clearly defined objectives based on local epidemiology and priorities according to risk assessment and functions that align with and contribute towards the prevention of HAI and the spread of AMR in health care.
- The GDG identified that IPC programmes should cover defined activities. As a minimum, these include:
 - › Surveillance of HAIs and AMR.
 - › IPC activities related to patients, visitors and health care workers' safety and the prevention of AMR transmission.
 - › Development or adaptation of guidelines and standardization of effective preventive practices (standard operating procedures) and their implementation.
 - › Outbreak prevention and response, including triage, screening, and risk assessment especially during community outbreaks of communicable disease.
 - › Health care worker education and practical training.
 - › Maintaining effective aseptic techniques for health care practices.
 - › Assessment and feedback of compliance with IPC practices.
 - › Assurance of continuous procurement of adequate supplies relevant for IPC practices, including innovative equipment when necessary, as well as functioning WASH services that include water and sanitation facilities and a health care waste disposal infrastructure.
 - › Assurance that patient care activities are undertaken in a clean and hygienic environment and supported by adequate infrastructures.
- The GDG considers that it is critical for a functioning IPC programme to have dedicated, trained professionals in every acute care facility. A minimum ratio of one full-time or equivalent infection preventionist (nurse or physician)

per 250 beds (37) should be available. However, there was a strong opinion that a higher ratio should be considered, for example, one infection preventionist per 100 beds, due to increasing patient acuity and complexity, as well as the multiple roles and responsibilities of the modern preventionist (38). For this reason, it is important that all infection preventionists are subject to review and regular updates of infection control competencies (refer to Core component #3: Infection prevention and control education and training).

- Although the scope of the evidence review and these recommendations addresses acute care facilities, the GDG considered it equally critical that all types of health care facilities have IPC support. Depending on the size and type of facility, such support might include an IPC committee comprising a trained and dedicated team to support several facilities and a “roaming” infection preventionist with regularly scheduled visits to support
- outpatient and other peripheral facilities. Clinics providing specialized treatment and care for patients with highly transmissible communicable diseases (for example, tuberculosis) should have an IPC programme or an on-site service to support the prevention of disease spread.
- Reporting lines for IPC teams should be clear both within facilities and externally.
- The GDG was of the opinion that health facility IPC programmes should be aligned to national programmes and interlinked with public health initiatives and the IHR, in particular for the reporting of communicable diseases or other unusual events of relevance for public health to the appropriate local, regional and national authorities, including those related to AMR. Thus, efficient means of communication should be in place between facilities, authorities and other public health services.
- Additional consideration should be given to data management systems as they are needed to support IPC activities.

Background

IPC programmes are one component of safe, high-quality health service delivery. HAI are one of the most common complications or adverse events affecting patients and health care workers. They result in increased morbidity and mortality and impact on the capacity of health systems to function effectively. HAI also increase health care costs and can result in the increased usage of antimicrobial agents, thereby fuelling the problem of AMR. In 2011, WHO reported that 7% of patients in developed and 10% in developing countries will acquire at least one HAI at any given time. Limited data are available from LMICs, but the prevalence of HAI is estimated to be between 5.7% and 19.1%.

A WHO survey published in 2015 (39) explored existing national policies and activities in the area of AMR in 133 Member States to determine the existence of effective practices and structures and highlight gaps. This situational analysis revealed major weaknesses in IPC capacity. Relatively few countries had a national IPC programme (54/133; 41%) in place and even fewer reported a programme in all tertiary

hospitals (39/133; 29%). At least half of all Member States in the European, South-East Asia and Western Pacific Regions reported having such a programme. However, fewer stated that this extended across all tertiary hospitals. In the African Region, a national IPC programme was present in 11 (42%) countries, with only four (15%) having such a programme in all tertiary hospitals (39).

The inventory of IPC national strategy or action plan documents conducted as part of the background for these guidelines showed that across all regions the vast majority of these documents (85%) address IPC programme structure and goals. However, only 60% specify the importance of having qualified and dedicated staff to support the programme and 44% highlight the need for an adequate budget and WASH infrastructure (web Appendix III).

Considering the above-mentioned issues, the GDG explored the evidence captured within a systematic review to identify the requirements and effectiveness of IPC programmes to improve IPC practices and reduce HAI and AMR.

Summary of the evidence

The purpose of the evidence review (web Appendix I) was to evaluate the effectiveness of IPC programmes established at the acute health care facility level. The primary outcomes were specific HAI rates and hand hygiene compliance. Only two studies (one controlled before-after study (37) and one interrupted time series) (40) were included, both from one high-income country.

The report of Haley and colleagues describes a landmark study in the field of IPC. Following implementation of an IPC programme including one full-time infection control nurse per 250 beds, urinary tract infection, pneumonia (post-surgery) and bacteraemia were reduced significantly among high risk patients by 31%, 27% and 15%, respectively (37). Among low risk patients, urinary tract infection and pneumonia (medical patients) were reduced significantly by 44% and 13%, respectively (37). Protection against HAI waned as the number of occupied beds per full-time equivalent infection control nurse increased from 250 to 400 beds and then levelled off (37). Furthermore, the study showed that significant increases of secular trends for SSI, urinary tract infection, pneumonia and bacteraemia (+13.8%, +18.5%, +9.3% and +25.5%, respectively) were observed in facilities (33%) with no established IPC programme compared to hospitals with IPC programmes. Of note, significant decreases for SSI, urinary tract infection and bacteraemia (-48%, -35.8, and -27.6%, respectively) were observed in the latter group (37).

Mermel and colleagues reported the results of a hospital-wide, multidisciplinary 6-pronged approach to combat endemic *Clostridium difficile* infection. The most notable interventions were the development of an IPC action plan, improved monitoring and surveillance, improved sensitivity of *C. difficile* toxin testing, enhanced cleaning and an appropriate treatment plan (40). An overall decrease in *C. difficile* incidence was observed from 12.2/1000 discharges during the second quarter of 2006 to 3.6/1000 discharges during the third quarter of 2012 ($P < 0.005$) (40).

When applying the EPOC risk of bias assessment to both studies, the GDG agreed that there is very low quality of evidence showing that IPC programmes are effective in preventing HAI as both studies demonstrated an overall high risk of bias. In the study by Haley and colleagues (37), the allocation sequence generation and concealment was considered as a high risk, while the risk related to blinding to the primary outcome remained unclear. In the report of Mermel and colleagues (40), both the shape of the intervention effect and data collection were high risk, while the intervention independence, blinding to the primary outcome and incomplete primary outcome data were

unclear. Both studies were performed in a single high-income country (USA). It was noted also that the Haley study was conducted more than 30 years ago. Therefore, it is potentially not a reflection of the current complexity of health care, the remit of IPC programmes and the evolution in the roles and responsibilities of IPC personnel.

While acknowledging the limitations of the evidence included in the systematic review, the GDG proposed that strong consideration be given to the Delphi project (38) as this publication is recognized internationally and takes into consideration the evolution of the roles and responsibilities of infection preventionists, as well as additional factors, such as the increasing acuity of patients and activity of health care settings. For these reasons, the GDG suggested a ratio of one infection preventionist to 100 hospital beds, but no less than the recommended one infection preventionist to 250 hospital beds, according to the evidence.

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this intervention. The GDG is confident that patients and the public are strongly supportive of IPC programmes, including the presence of infection preventionists, as an accepted strategy to reduce the risk of HAI. Furthermore, health care providers and policy-makers across all settings are likely to be in support of IPC programmes and staff to reduce the harm caused by HAI and AMR and to achieve safe, quality health service delivery in the context of universal health coverage.

Resource implications

The GDG is confident that the recommendation can be accomplished in all countries, but it did acknowledge that there will be particular resource implications for LMICs, most notably, limited access to qualified and trained IPC professionals. At present, a defined career path for IPC does not exist in some countries, thus restricting health care workers professional development. Furthermore, human resource capacity is often limited, especially with respect to available doctors. Many countries have an experience of implementing IPC programmes and data from high- and middle-income countries indicate that it is feasible and effective. However, in settings with limited resources, there is a need for prioritization and use of the most effective approaches.

Finally, the GDG agreed that not all countries will have adequate budgets and expertise to fully support all aspects

of an IPC programme when executed to its fullest extent. Although the evidence is limited to high-resource settings, the expert panel believes that the resources invested are worth the net gain, irrespective of the context. Thus, the provision of secured budget lines will be important to support the full implementation of IPC activities.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable, while recognizing that it requires widespread and executive support, as well as specific actions for stakeholder engagement. The need for effective advocacy to assist in the acceptance of the recommendation moving forward was noted.

Conclusions

After careful evaluation of the available evidence, the panel recommended that an IPC programme with a dedicated, trained team should be in place in each acute health care facility for the purpose of preventing HAI and AMR. The panel also believes that all types of health care facility should have some form of IPC support from a trained team, with scope and time dedication depending on the type of facility.

Research gaps

The GDG indicated the need for additional well-designed research studies, especially from LMICs, as the only available evidence is from high-income countries, which is difficult to apply more broadly. Furthermore, there is a strong request for more investigations that examine the impact and ideal composition of an IPC programme, including minimum standards for IPC training, and studies on cost-effectiveness to determine adequate budgeting for IPC activities. The GDG also highlighted that more insight is needed on the impact of an effective IPC programme in support of strategies to improve hygiene and IPC in the community.

Additional implementation considerations

The GDG outlined a number of additional points to be considered in the implementation of the recommendation.

- The GDG unanimously agreed that nursing staff must be engaged to form a central part of the IPC programme as the vast majority of health care in LMICs is nurse-driven with less access to medical doctors than in high-income countries. Nevertheless, if resources permit, the GDG recommends that an IPC programme should have both doctors and nurses with specialized IPC training. In addition, cleaners and janitorial staff should be trained, as appropriate, on specific aspects of IPC.
- The facility leadership should clearly support the IPC programme by providing materials and organizational and administrative support through the allocation of a protected

and dedicated budget, according to the IPC activity plan. This budget should also ensure support for the adequate functioning of WASH services that are necessary to undertake IPC. Importantly, the ultimate accountability for IPC programmes lies with the facility leadership.

- Within the facility, the IPC team should have established links and communication mechanisms, in particular with the following services: laboratory and biosafety; waste management, sanitation, water supply, cleaning and sterilization; occupational health; pharmacy; and patient safety and quality of care.
- The GDG emphasized the importance of the IPC programme/team being linked with the occupational health professionals (if available) within the facility, to collaborate on all aspects of health care worker safety relevant to infection prevention, such as post-exposure prophylaxis, outbreak management, choosing optimal personal protective equipment, etc.
- The GDG identified that good quality microbiological laboratory support is a very critical factor for an effective IPC programme. The identification and characterization of the aetiological agents responsible for infection is especially useful for the early detection of outbreaks where the identification of the pathogen concerned and/or distinct patterns of AMR are crucial. It also provides data on the local endemic epidemiology of HAI and local AMR patterns, which can all provide relevant information for policy and action plan development. Use of antimicrobial consumption data can provide relevant information for the development of antibiotic formulary guidelines and an action plan to combat AMR.

Core component 1: Infection prevention and control programmes

■ 1b. National level

GOOD PRACTICE STATEMENT

Active, stand-alone, national IPC programmes with clearly defined objectives, functions and activities should be established for the purpose of preventing HAI and combating AMR through IPC good practices. National IPC programmes should be linked with other relevant national programmes and professional organizations.

Rationale for the good practice statement

- Although several studies concerning the implementation of nationwide multimodal programmes with the aim to reduce specific types of infections (for example, catheter-associated bloodstream infection) were retrieved, no study was available to evaluate the effectiveness of establishing a more comprehensive national IPC programme and its organization and therefore to formulate a recommendation. However, experts and country representatives brought very clear examples where an active and sustained national IPC programme with effectively implemented plans has led to the improvement of national HAI rates and/or the reduction of infections due to multidrug-resistant organisms. Therefore, the GDG strongly affirmed that each country should have a stand-alone, active national IPC programme to prevent HAI, to combat AMR through IPC good practices and ultimately achieve safe, high-quality health service delivery.

Remarks

- The GDG strongly concurred that the organization of national IPC programmes must be established with clear objectives, functions, appointed infection preventionists and a defined scope of responsibilities. Minimum objectives should include:
 - › goals to be achieved for endemic and epidemic infections
 - › development of recommendations for IPC processes and practices that are known to be effective in preventing HAI and the spread of AMR.
- The GDG proposed that the organization of the programme should include (but not be limited to) at least the following components:
 - › Appointed technical team of trained infection preventionists including medical and nursing professionals.
 - › The technical teams should have formal IPC training and allocated time according to tasks.
 - › The team should have the authority to make decisions and to influence field implementation.
 - › The team should have a protected and dedicated budget according to planned IPC activity and support by national authorities and leaders (for example, chief medical officer, minister of health).
- The IHR (2005) and the WHO Global Action Plan on AMR (2015) support national level action on IPC as a central part of health systems' capacity building and preparedness. This includes the development of national plans for preventing HAI, the development or strengthening of national policies and standards of practice regarding IPC activities in health care facilities, and the associated monitoring of the implementation of and adherence to these national policies and standards. Therefore, the panel unanimously agreed that national IPC activities are essential to support HAI and AMR prevention among patients, health care workers and visitors.
- The IHR require Member States to notify WHO of events that may constitute a public health emergency of international concern and outline the importance of IPC practices at the health care facility level for the purposes of containment following such events (14). The current monitoring and assessment tool for IHR core capacity (16) strongly features IPC, which is specifically mentioned as one of 20 indicators: "IPC is established and functioning at national and hospital levels" (16). IHR monitoring and evaluation is currently under review and IPC is anticipated to feature strongly in the new approach (expected to be published in 2016).
- The linkages between the national IPC programme and other related programmes are key and should be established and maintained including:
 - › WASH
 - › Environmental authorities
 - › Prevention and containment of AMR, including an antimicrobial stewardship programme
 - › Tuberculosis, human immunodeficiency virus and other priority public health programmes

- › National referral laboratories
- › Laboratory biosafety
- › Occupational health
- › Quality of health service delivery
- › Patient safety
- › Waste management and other environmental issues
- › Patients' associations/civil society bodies
- › Scientific professional organizations (that is, medical, nursing and allied health professionals)
- › Training establishments/academia
- › Relevant teams or programmes in other ministries
- › Relevant sub-national bodies, such as provincial or district health offices
- › Immunization programme
- › Maternal and child health
- The GDG emphasized the regulatory aspect and importance of national IPC standards, including the development, dissemination and implementation of technical evidence-based guidelines for the prevention of the relevant risks informed by local risk assessment and/or infections adapted to local conditions. The GDG noted that the basic set of IPC guidelines should include at least the following:
 - › Standard precautions
 - › hand hygiene
 - › use of personal protective equipment
 - › sterilization and medical devices decontamination
 - › safe handling of linen and laundry
 - › health care waste management
 - › patient placement
 - › respiratory hygiene and cough etiquette
 - › environmental cleaning
 - › principles of asepsis
 - › prevention of injuries from sharp instruments and post-exposure prophylaxis
 - › Transmission-based precautions
 - › Aseptic technique and device management for clinical procedures, according to the scope of care. Since the scope of practices may be very different in health care facilities according to the type of care offered, the guidelines should prioritize the most frequent and/or risky practices (for example, use of indwelling catheters and other devices, surgery, and other invasive procedures) and settings (for example, operating room, ICUs, neonatal wards, central reprocessing, hemodialysis unit, etc.).
- National IPC programmes must support the development and enhancement of advanced educational programmes on this topic. Three categories of human resources were identified as targets for IPC training.
- IPC specialists: members of the technical teams responsible for IPC programmes who should be trained to achieve an expert level covering all areas of IPC.
- All health care workers involved in service delivery and patient care: clinical staff (doctors, nurses, dentists, medical assistants, etc.), laboratory and other health care workers (for example, cleaners) who require a basic understanding of all relevant IPC measures embedded within clinical procedures, precautions for biohazard security and risks associated with the health care environment.
 - › Other personnel that support health service delivery: these include administrative, managerial and all other support staff (for example, local authorities and hospital administrators/managers and executive leaders) responsible and accountable for the safety and quality of health services who should understand the importance of supporting IPC infrastructure and practices to reduce overall harm to patients and frontline health workers and associated costs.
- Early participation of stakeholders (health authorities, health care facilities, scientific societies, patient organizations, WASH professional groups and ministries of health) in the production of national standards and guidelines may contribute to achieving consensus and facilitating their implementation.

Additional implementation considerations

The GDG outlined a number of additional points to be considered in the implementation of the recommendation.

- The GDG outlined a basic set of key activities that the national IPC team should lead, which should include aspects related to:
 - › Surveillance of HAIs, as well as AMR, and dissemination of data
 - › Ensuring implementation of at least:
 - standard precautions
 - transmission-based precautions
 - appropriate selection and use of IPC supplies (for example, personal protective equipment, hand hygiene products, antiseptics, etc.)
 - preventative techniques for clinical procedures (that is, sterile procedures, surgery, catheter insertion)
 - sterilization and disinfection of clinical materials
 - waste management, adequate access to safe water, sanitation and environmental cleaning
 - › Development of national technical guidelines, standard operating procedures and implementation strategies
 - › Outbreak prevention and response, including ensuring that a national plan is in place
 - › Training of health care workers
 - › Assessment and feedback of compliance with IPC practices (including the dissemination and use of data)
 - › Assurance of national procurement of adequate supplies relevant for IPC practices
 - › Coordination or collaboration with relevant ministries
 - › Monitoring and evaluation of the national IPC programme.
- The GDG agreed that the programme might use local experience and knowledge obtained from successful interventions as a base for the development of strategies. A system for the documentation and dissemination of successful local or national initiatives should be established to highlight examples of effective interventions and their implementation. In particular, these need to have a focus on their effectiveness in the context of existing resources, while taking into account the local culture and specific setting.
- The GDG considered it beneficial that an official multidisciplinary group, committee or an equivalent structure be established to interact with the technical team responsible for the IPC programme. The mandate of this entity would be to integrate IPC in the national health system and enhance cooperation, coordination and information-sharing, particularly with national bodies responsible for quality policy and strategy and universal health coverage. Other tasks of the group could be to perform a review of the programme content, promote improved practices, ensure appropriate training, review risks associated with new technologies and periodically evaluate the programme.
- The GDG highlighted that good quality microbiological support to clinical laboratories provided by at least one national reference laboratory is a critical factor for an effective national IPC programme. The identification and characterization of the aetiological agents responsible for infection is especially useful for the early detection and the microbiological confirmation of outbreaks, which may have national or sub-national relevance, including identification of the pathogen and/or a distinct pattern of AMR. Microbiology support also provides national data on the epidemiology of HAI and AMR patterns, which can provide relevant information for policies and the development of action plans. Strict adherence to laboratory standards and biosafety measures are vital for effective microbiological techniques and unbiased interpretations of results.
- The GDG emphasized the regulatory aspect and importance of national IPC standards, including the development, dissemination and implementation of technical evidence-based guidelines for the prevention of the relevant risks informed by local risk assessment and/or infections adapted to local conditions. The GDG noted that the basic set of IPC guidelines should include at least the following:
 - › Standard precautions
 - hand hygiene
 - use of personal protective equipment
 - sterilization and medical devices decontamination
 - safe handling of linen and laundry
 - health care waste management
 - patient placement
 - respiratory hygiene and cough etiquette
 - environmental cleaning
 - principles of asepsis
 - prevention of injuries from sharp instruments and post-exposure prophylaxis
 - › Transmission-based precautions
 - › Aseptic technique and device management for clinical procedures, according to the scope of care. Since the scope of practices may be very different in health care facilities according to the type of care offered, the guidelines should prioritize the most frequent and/or risky practices (for example, use of indwelling catheters and other devices, surgery, and other invasive procedures) and settings (for example, operating room, ICUs, neonatal wards, central reprocessing, hemodialysis unit, etc.).

Core component 2: National and facility level infection prevention and control guidelines

RECOMMENDATION

The panel recommends that evidence-based guidelines should be developed and implemented for the purpose of reducing HAI and AMR. The education and training of relevant health care workers on the guideline recommendations and the monitoring of adherence with guideline recommendations should be undertaken to achieve successful implementation.

(Strong recommendation, very low quality of evidence)

Rationale for the recommendation

- Evaluation of the evidence from six studies shows that guidelines on the most important IPC good practices and procedures are effective to reduce HAI when implemented in combination with health care workers' education and training. Due to different methodologies and different outcome measures, no meta-analysis was performed. The overall quality of the evidence was very low. However, the GDG unanimously decided to recommend the development and implementation of IPC guidelines, supported by health care workers' education and training and monitoring of adherence to guidelines, and that the strength of this recommendation should be strong.

Remarks

- The GDG noted that appropriate IPC and other relevant expertise is necessary to write or adapt and adopt a guideline both at the national and health care facility level. Guidelines should be evidence-based and reference international or national standards. Adaptation to local conditions should be considered for the most effective uptake and implementation.
- Developing relevant evidence-based national IPC guidelines and related implementation strategies is one of the key functions of the national IPC programme (see Core component 1).
- The national IPC programme should ensure also that the necessary infrastructure and supplies to enable guideline implementation are in place, complementing relevant guidelines on AMR and health care worker protection. The national IPC programme should support and mandate health care workers' education and training focused on the guideline recommendations.
- The GDG placed an emphasis on the early engagement and participation of stakeholders in the development and production of guidelines to achieve consensus and support the implementation phases.
- Monitoring adherence to guideline implementation is essential to evaluate its adoption and effectiveness to achieve the desired outcomes and to assist with adjustments and improvements of the implementation strategies.
- Health care worker protection should also be the object of guidelines or protocols, ideally under the responsibility of occupational health professionals in collaboration with the IPC team. With regards to infectious risks, health care worker protection should include pre-employment screening to be repeated regularly during employment and vaccinations.
- The GDG also noted that regular updates are required to ensure that the guidelines reflect current evidence.

Background

The field of IPC has accumulated considerable knowledge on effective preventive interventions, many of which are simple and cost effective. The availability of technical guidelines consistent with the available evidence is essential to provide a technical framework to support the performance of good practices. However, the existence of guidelines alone is not sufficient to ensure their adoption and implementation science principles and findings clearly indicate that local

adaptation is a prerequisite for successful guideline adoption. In a recent survey conducted by WHO as a background to these guidelines (web Appendix III), it was identified that on average, 74% of national IPC documents address the development, dissemination and implementation of technical guidelines and 43% emphasize the importance of local adaptation. Over 80% of national documents address the need for the training of all staff in IPC measures.

Summary of the evidence

The purpose of the evidence review (web Appendix I) was to evaluate the effectiveness of IPC programmes. One component identified was the use of guidelines in combination with the education and training of health care workers. The primary outcome was the impact on HAI and hand hygiene compliance. A total of six studies comprising three non-controlled before-after studies (41-43), one non-controlled interrupted time series (44) and two qualitative studies (45, 46) were retrieved through the SIGHT review (2), which is part of the evidence for these guidelines. Three reports were from an upper-middle-income country (Argentina) and the remaining ones were from the USA.

Larson and colleagues highlighted the importance of guideline implementation in the field in a survey involving 1158 health care workers in 40 hospitals in the USA. They found that although health care workers were aware of the update of a national guideline on hand hygiene, the recommendations had been implemented only in less than half of the hospitals visited (41). A study by Rubinson and colleagues showed a low adherence to maximal sterile barrier precautions for the insertion of central venous catheters by internists. Among those who were highly adherent, only a minority was aware of the content of the US Centers for Disease Control and Prevention guidelines (45). The conclusion was that knowledge of guidelines alone is insufficient for behavioural change. Moreover, attitudes towards guidelines were more positive among nurses than doctors and in paediatric ICUs than in adult ICUs (46).

The introduction of a new guideline as part of a multimodal intervention strategy in settings without previous exposure to standardized protocols helped to improve hand hygiene and to reduce rates of catheter-associated urinary tract infection (42-44) in the context of a national network in Argentina.

As the included studies were all from the SIGHT review (2) and they do not meet the recommended study designs by the EPOC group (9), the GDG considered that the overall quality of the evidence was very low.

Non-EPOC studies

In the update of the SIGHT review performed for these guidelines, one additional study was retrieved (web Appendix I) that concurs with the evidence summarized above, but it did not meet the EPOC study design criteria. In this study by Kachare and colleagues (non-controlled before-after), the implementation of hospital-wide catheter guidelines and specific measures aimed at early catheter removal

demonstrated an 85% significant reduction in the number of catheter-associated urinary tract infections and increased hand hygiene compliance (58% vs. 92%, respectively; $P=0.05$) (47).

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this intervention. The GDG is confident that the typical values and preferences of health care providers, policy-makers and patients would favour this intervention. Health care providers, policy-makers and health care workers are likely to place a high value on evidence-based guidelines.

Resource implications

The GDG is confident that the resources are worth the expected net benefit from following this recommendation, while recognizing that the implementation and local adaptation of technical guidelines will require some level of resources and materials. This will include the necessary human resources for development and adaptation, as well as materials and equipment for execution, although some solutions may likely be low cost.

Feasibility

The GDG is confident that this recommendation can be accomplished in all countries. However, the panel did note that feasibility would hinge on the presence of IPC programmes, IPC expertise and availability of materials and equipment to assist in appropriate local adaptation.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable.

Conclusions

After careful evaluation of the evidence, the GDG recommended that evidence-based practice guidelines should be developed and implemented for the purpose of reducing HAIs and AMR as part of a broad multimodal improvement approach including health care workers' education and training.

Research gaps

During the GDG discussions, particular gaps in the available research were identified. The panel suggested the need for additional evaluation of the effectiveness of local adaptation and implementation of technical guidelines, especially those

referencing international and national standards. A proposal was made to conduct a situational analysis of guidelines in countries and their mechanisms for implementation to achieve the desired culture change.

Additional implementation considerations

The GDG outlined a number of additional points to be considered in the implementation of the recommendation.

- The implementation of evidence-based practice guidelines should be informed by principles of behaviour and culture change.
- The GDG noted that the basic set of IPC guidelines should include the following:
 - › Standard precautions (see Core component 1)
 - › Transmission-based precautions, including patient identification, placement and the use of personal protective equipment.
 - › Aseptic technique for invasive procedures (including surgery) and device management for clinical procedures, according to the scope and type of care delivered at the facility level.
 - › Specific guidelines to prevent the most prevalent HAIs (for example, catheter-associated urinary tract infection, SSI, central line-associated bloodstream infection, ventilator-associated pneumonia) depending on the context and complexity of care.
- However, guidelines should be prioritized locally based on the most frequent practices and/or with practices associated with an increase in the risk of HAI and adapted to local circumstances (for example, use of indwelling catheters and other devices, surgery, and other invasive procedures).

Core component 3: Infection prevention and control education and training

■ 3a. Health care facility level

RECOMMENDATION

The panel recommends that IPC education should be in place for all health care workers by utilizing team- and task-based strategies that are participatory and include bedside and simulation training to reduce the risk of HAI and AMR.

(Strong recommendation, very low quality of evidence)

Rationale for recommendation

- Evaluation of the evidence from 15 studies shows that IPC education that involves frontline health care workers in a practical, hands-on approach and incorporates individual experiences is associated with decreased HAI and increased hand hygiene compliance. However, due to the varied methodologies and different outcomes measured, no meta-analysis was performed. As a result, the GDG decided that IPC education and training should be in place for all health care workers using a team- and task-oriented approach. The overall quality of the evidence was moderate, but the GDG unanimously decided that the strength of this recommendation should be strong.

Remarks

- The GDG noted that IPC education and training should be a part of an overall health facility education strategy, including new employee orientation and the provision of continuous educational opportunities for existing staff, regardless of level and position (for example, senior administrative and housekeeping staff). Special circumstances may arise that require ad hoc training, such as during outbreaks or other public health emergencies.
- Although there is relatively little evidence to support the embedding of IPC training horizontally across service areas and procedures, the GDG supported the view that training is most effective and efficient if it is embedded within clinical practice training, rather than delivered in a “stand-alone” isolated manner.
- Three categories of human resources were identified by the GDG as the target for IPC training requiring different strategies and training contents:
 - › IPC specialists: doctors, nurses and other professionals who are members of the technical teams responsible for the IPC programme. This group of professionals should be trained to achieve an expert level of knowledge covering all areas relevant to IPC, including patient and health care worker safety and quality improvement. To maintain high-level expertise, it is important that all IPC specialists undergo regular updates of their competencies.
 - › All health care workers involved in service delivery and patient care: clinical staff (doctors, nurses, dentists, medical assistants, etc.), laboratory and other health care workers (for example, cleaners). In particular, these professionals should understand IPC measures embedded within clinical procedures, the importance of precautions for biohazard security and the risks associated with the environment.
 - › Other personnel that support health service delivery: these include cleaners responsible for the day-to-day cleaning of the facility, auxiliary service staff and administrative and managerial staff (for example, local authorities and hospital administrators/managers and executive leaders) responsible and accountable for the safety and quality of health service delivery, including the overall implementation of policies and guidelines and the monitoring of national and local policies. Senior managers should understand the importance of supporting IPC infrastructure and practices to reduce harm to patient and health care workers and therefore the associated costs.
- The GDG emphasized that strong consideration should be given to incorporating in-service mentorship into health facilities as it has been shown to be successful in achieving behaviour change in other fields. One example could be the use of IPC link practitioners as unit-based resources or champions.
- The GDG strongly agreed that periodic evaluations of both the effectiveness of training programmes and assessments of staff knowledge should be undertaken on a routine basis to ensure optimal education delivery, uptake and practice. For further information, please see core component 6 on auditing and feedback.

Background

IPC education spans all domains of health service delivery and is relevant to all health care workers, ranging from frontline workers to administrative management. Effective IPC education and training is predicated on employing the right educational method to achieve maximal learning and behaviour change. Education and training must be pertinent and relevant to the tasks that each worker is required to perform.

Summary of the evidence

The purpose of the evidence review (web Appendix I) was to evaluate the effectiveness of IPC programmes. One component identified was health care worker training and education on IPC good practices. The primary outcome was the impact on HAI and hand hygiene compliance.

A total of 15 studies comprising five interrupted case series (48-52), five qualitative (46, 53-56), two controlled before-after (57, 58), two non-controlled before-after (59, 60) and one mixed methods (61) were included. Twelve studies were from high-income countries (46, 48-51, 54-57, 59-61), two from one upper-middle-income country (52, 58) and one from a LMIC (53).

In six studies, a reduction of catheter-related bloodstream infections were associated with bedside teaching as a prominent part of multimodal interventions (60), including simulation-based training (48, 49, 57) and hands-on or in-person training workshops (50, 59). In a study by Viana and colleagues, the introduction of an educational module for the prevention of ventilator-associated pneumonia was associated with an overall reduction in mean ventilator-associated pneumonia rates (52). Conversely, the introduction of a volunteer, self-directed, automated training system for hand hygiene by Kwok and colleagues did not result in any change in overall hand hygiene compliance (51).

Although formal training can be effective (52, 56), individual experience is perceived to be more important for IPC (54). As an example, strategies that use traditional approaches based on logic and reasoning were perceived as less likely to improve hand hygiene (55). In three studies, the use of multidisciplinary focus groups to engage frontline health care workers was crucial to identify common IPC strategies and contributed to improved hand hygiene compliance and reduced rates of HAI (53, 58, 61).

The overall quality of this evidence was considered as moderate by the GDG given that the studies included

in the SIGHT review (2) were graded as high quality. However, most trials did not meet the recommended EPOC study designs (9) and the studies identified by the update of the review had a medium to high risk of bias.

Non-EPOC studies

In the SIGHT review update, an additional 21 studies comprising 20 non-controlled before-after (62-81) and one non-controlled cohort trial (82) were retrieved (web Appendix I). Although they did not meet the EPOC criteria (9), it was considered that these studies could provide further insight into effective IPC educational approaches. Hands-on or in-person group training sessions as part of multimodal interventions (68, 70), including e-learning modules (62, 69), task-oriented training sessions (64) and lectures (63, 65-67), were associated with increased hand hygiene compliance (81) and decreased HAI (80). Simulation-based training (71, 76) was associated with a decrease in catheter-related bloodstream infection. Dedicated teams or IPC link nurses/practitioners were also associated with decreased MRSA acquisition (75), increased hand hygiene (75) and decreased catheter-related bloodstream infection (82). In two studies, group sessions with online modules and lectures were associated with an overall reduction in ventilator-associated pneumonia (77, 78), while more targeted training courses for specialized care showed a decrease in bloodstream infection (72, 73, 79).

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this intervention. The GDG is confident that health care providers, policy-makers and patients in all settings are likely to place value on the need for effective training and education as part of a multimodal strategy to reduce HAI and to combat AMR.

Resource implications

The GDG is confident that the resources are worth the expected net benefit from following this recommendation. However, it recognizes that certain educational and training methods may pose an implementation challenge in some low-resource settings.

Feasibility

The GDG is confident that this recommendation can be accomplished in all countries and acknowledges that continuous education may be difficult and challenging in

some countries, particularly where there is a low availability or lack of knowledgeable professionals able to teach IPC. In addition, the recommendation is likely to require adaptation or tailoring to the cultural setting.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable.

Conclusions

Following careful evaluation of the available evidence, the GDG recommended that IPC training and education should be in place for all health care workers using team- and task-based strategies, including bedside and simulation training, to reduce the risk of HAIs and combat AMR.

Research gaps

The GDG emphasized the need to ensure that lessons learned from innovative new programmes are evaluated and utilized for improving IPC education and training delivery. Moreover, more research is required to evaluate the effectiveness of e-learning, self-directed training modules and mentorship as tools for IPC education and their associated impact on HAI. Additional studies are required to better understand the impact of patient and family education on HAI.

Additional implementation considerations

The GDG outlined a number of additional points to be considered in the implementation of the recommendation.

- The GDG agreed that the IPC team should be responsible for the design and development of IPC education and training within the facility. Providing basic IPC training may not necessarily be the task of only the IPC teams, but a part of a larger training approach (for example, train the trainer) to maximize available human resources.
- The GDG noted that educational approaches should be informed by behavioural change theories and methods. The GDG also emphasized that in addition to teaching the basic concepts and theories of microbiology, infectious diseases and IPC, consideration should be given to using a range of educational modalities to maximize the impact of health care worker training. The following training methods could be included: problem-based learning; hands-on workshops; focus groups; peer-to-peer training; classroom-based simulation; and bedside training. Such training should be complementary to WASH training and, if this does not exist, key WASH aspects necessary for IPC implementation should be incorporated.

- The GDG discussed the possibility of using a twinning partnership model, such as that used by the African Partnerships for Patient Safety (<http://www.who.int/patientsafety/implementation/apps/en/>), a WHO patient safety programme, to support local IPC training. This model facilitated the development of sustainable hospital-to-hospital patient safety partnerships centred on IPC and advocated patient safety as a precondition of health care. A twinning partnership approach has the potential to increase access to technical resources (for example, IPC expertise) and to provide support for appropriate local IPC training.
- The GDG recognized that although there was no evidence on the benefits of patient education, patient empowerment remains an important consideration. In particular, whenever family members assume care activities, they should receive targeted or tailored IPC training in order to protect themselves and their loved ones and thus minimize any possibility of cross-transmission.

Core component 3: Infection prevention and control education and training

■ 3b. National level

GOOD PRACTICE STATEMENT

The national IPC programme should support education and training of the health workforce as one of its core functions.

Rationale for the good practice statement

- Several studies related to the implementation of nationwide multimodal programmes were retrieved (see Core component 5). These included a strong health care worker education and training component with the aim to reduce specific types of infections (for example, catheter-associated bloodstream infections). In addition, health care worker training was found to be an essential component for effective guidelines implementation (see Core component 2). However, there was no specific evidence on the effectiveness of national curricula or IPC education and training per se. Nevertheless, the GDG deemed it important to develop a good practice statement to recommend that IPC national programmes should support education and training of the health workforce as one of its core functions to prevent HAIs and AMR and to achieve safe, high-quality health service delivery.

Remarks

- The IPC national team plays a key role to support and make IPC training happen at the facility level as described in section 3a.
- The ultimate aim of this activity is to have the presence of a skilled and knowledgeable health workforce. This should include both IPC specialists and all professionals with a solid basic IPC knowledge among health care workers involved in service delivery and patient care, as well as senior managers.
- The GDG highlighted that in order to support the development and maintenance of a skilled, knowledgeable health workforce, national IPC curricula should be developed in collaboration with local academic institutions. Curricula should be developed for both pre-graduate and postgraduate courses. The former are intended to provide students in the health domain with a basic solid education on IPC principles and best practices, whereas the latter are intended to train professionals to become IPC specialists by creating a career path and an IPC specialty. In the curricula development process, it is advisable to refer to international curricula and networks for specialized IPC programmes and to adapt these documents and approaches to national needs and local available resources.
- The GDG identified also that the national IPC programme should provide guidance and recommendations for in-service training to be rolled out at the facility level according to detailed IPC core competencies for health care workers and covering all professional categories listed in core component 3a.
- The GDG agreed that supporting and facilitating training at all levels should be considered as an important indicator for assessing the relevance of IPC programmes.
- The GDG noted that in addition to general IPC educational activities, the need for specific training to support the implementation of national HAI surveillance activities is critical to ensure their efficiency and reliability.

Additional implementation considerations

The GDG outlined a number of additional points to be considered in the implementation of the recommendation.

- Ideally, the national IPC team should develop also some standardized training tools to support curricula implementation. These should be in line with national technical guidelines and international IPC standards.
- In addition to the curricula and tools' development, appropriate steps should be undertaken for the approval, adoption and roll-out of the curricula by all health faculties (for example, medicine, nursing, midwifery, dentistry, laboratory, etc.).
- The GDG highlighted also the need to consider all available and emerging technologies within the field of e-health to support training and education, for example, social media.

Core component 4: Health care-associated infection surveillance

■ 4a. Health care facility level

RECOMMENDATION

The panel recommends that facility-based HAI surveillance should be performed to guide IPC interventions and detect outbreaks, including AMR surveillance with timely feedback of results to health care workers and stakeholders and through national networks.

(Strong recommendation, very low quality of evidence)

Rationale for the recommendation

- Evaluation of the evidence from 13 studies shows that a hospital-based surveillance system is associated with a decrease in HAI, including central line-associated bloodstream infections, ventilator-associated pneumonia, SSI, catheter-related urinary tract infections and catheter-related bloodstream infections, and that timely feedback of results are influential in the implementation of effective IPC actions. Due to varied methodologies and different outcomes measured, no meta-analysis was performed. As a result, the GDG decided that HAI surveillance with timely feedback of results should be performed to guide IPC interventions. The overall quality of the evidence was very low given the study designs and the high risk of bias across studies. However, given the importance of surveillance not only for reducing HAI and the early detection of outbreaks, but also for awareness-raising about the importance of HAI and AMR, the GDG unanimously decided that the strength of this recommendation should be strong.

Remarks

- The content of section 4a is strictly linked to section 4b by providing a good practice statement and details related to HAI surveillance at the national level. The GDG noted that the studies included for the health care facility level were also linked to a national network and are relevant also to support the good practice statement on national HAI surveillance.
- Surveillance of HAI is critical to inform and guide IPC strategies.
- The GDG suggests that health care facility surveillance should be based on national recommendations and standard definitions and customized to the facility according to available resources, with clear objectives and strategies. Surveillance should provide information for:
 - › Describing the status of infections associated with health care (that is, incidence and/or prevalence, type, aetiology and, ideally, data on severity and the attributable burden of disease).
 - › Identification of the most relevant AMR patterns.
 - › Identification of high-risk populations, procedures and exposures.
 - › Existence and functioning of a WASH infrastructure, such as water supply, toilets and health care waste destruction.
 - › Early detection of clusters and outbreaks (that is, early warning system).
 - › Evaluation of the impact of interventions.
- The GDG noted that the responsibility for planning and conducting surveillance and analysing, interpreting and disseminating the collected data remains usually with the IPC committee and the IPC team. Expertise in statistics and epidemiology is essential in these activities. The staff conducting surveillance should receive education on basic concepts in microbiology and communicable diseases.
- The GDG agreed that methods for detecting infections should be active. Passive surveillance should be discouraged because it has low sensitivity. Therefore, prospective surveillance is recommended rather than retrospective. Different surveillance strategies could include the use of prevalence or incidence studies (that is, site-oriented surveillance, department-oriented surveillance or priority-oriented surveillance). Most facilities identify specific infections as a priority for surveillance as the surveillance of all infections ('total surveillance') is not easily affordable and thus rarely done. There should be a process for deciding surveillance priorities.
- The GDG remarked upon the critical role of quality microbiology and laboratory capacity to enable reliable HAI surveillance. Importantly, such a capacity should be developed or available in all facilities in accordance with WHO laboratory standards (83).

- The GDG agreed that hospital-based infection surveillance systems should be linked to integrated public health infection surveillance systems. Information regarding diseases of potential concern should be reported immediately to the public health authorities. This is in agreement with the requirements of the IHR for 2005, which have been in force since June 2007. The IHR require Member States to develop the capacity to detect and report organisms (including those due to newly emerged resistance) that may constitute a public health emergency of international concern with associated notification to WHO. Likewise, IPC practices in health care must be in place for the purposes of containment following such events.
- The GDG emphasized that surveillance reports should be disseminated in a timely manner to those at the managerial or administration level (decision-makers) and the unit/ward level (frontline health care workers). The importance of sharing reports with all relevant players was noted in order to support both organizational and behavioural change as part of overall quality improvement efforts to reduce the risk of HAI and combat AMR (see core component 6, which provides further information related to the role of feedback in improvement). Dissemination of reports to committees responsible for safety and quality should be considered also since data on HAI are a quality marker.

Background

IPC activities should respond to the actual needs of the health care facility, based on the HAI situation and compliance with IPC practices. Facility-based surveillance systems contribute to the early detection of HAI, the identification of clusters and outbreaks and enable the effectiveness of IPC interventions to be assessed.

All surveillance systems should rely on good data quality, which includes the appropriate application of case definitions and good microbiological laboratory procedures. The latter is necessary for the identification of aetiological agents and AMR patterns as these have several implications for patients and IPC programmes. In a recent WHO survey conducted in 2015 on the global situational analysis of AMR, many regions noted poor laboratory capacity, infrastructure and data management as impediments to surveillance (39). The WHO Global AMR Surveillance System fosters the development of national AMR surveillance and suggests that countries should rely on at least one externally quality-assured reference laboratory to support AMR surveillance in the country (83). In addition, laboratory capacity varied by country and by region. The highest percentage of countries in which organisms are tested for antibiotic sensitivity was in the Region of the Americas. Although a national reference laboratory was reported by one country in each region, many did not participate in external quality assessments to ensure data quality on AMR. With the exception of 2 regions where most countries reported on AMR surveillance, national reports on this topic were infrequent (39).

Moreover, in the inventory of IPC national strategy or action plan documents conducted as the background for these guidelines, it was noted that most documents (79%) contain guidance relating to the establishment of priorities for surveillance, despite some regional variation (web Appendix

III). However, only 52% of documents address the need for standardized definitions with clear gaps in recommending surveillance in the context of outbreak response and detection.

Taking into consideration the strong emphasis on surveillance, together with laboratory support and feedback, the GDG reviewed the available evidence to determine the impact of surveillance on HAIs.

Summary of the evidence

The purpose of the evidence review (web Appendix I) was to evaluate the effectiveness of IPC programmes. One component identified was HAI surveillance and feedback. The primary outcome was HAI and hand hygiene compliance. A total of 13 studies comprising 11 non-controlled before-after (84-94), one interrupted time series (95) and one qualitative study (96) were included, all from high-income countries. Hospital-based infection surveillance systems linked to national surveillance networks were associated with decreased rates of overall HAI (84-89, 93, 94), central line-associated bloodstream infection (87, 88), ventilator-associated pneumonia (87, 94), urinary tract infection (86) and SSI (84, 85, 87, 89, 90). Hospitals within the Dutch national surveillance network showed reduced rates of HAI during years 4 and 5 (90) after surveillance started, while the 35 ICUs of the French surveillance network demonstrated a reduction in catheter-related bloodstream infection over 5 years (91). Active surveillance with public feedback as part of a MRSA bundle strategy was associated with a decrease in MRSA infections in a hospital in Singapore (95). One qualitative study explored the importance of surveillance and feedback to stakeholders and found that they were very influential in the implementation of an IPC programme targeting ventilator-associated pneumonia (96).

The quality of the evidence was graded as intermediate according to ICROMS criteria for the studies retrieved through the SIGHT review (2). However, given that these studies do not meet the EPOC recommended study design criteria (9), the GDG considered this evidence as very low quality. One study was identified through the review update and met the EPOC criteria, but it had a high risk of bias. All studies were performed in high-income countries only and, therefore, generalizability is uncertain or limited with regards to applicability in LMICs.

Non-EPOC studies

An additional eight studies comprising four non-controlled cohort trials (97-100) and three non-controlled before-after (101-104) were retrieved from the updated SIGHT review (web Appendix I). Although they did not meet the EPOC criteria (9), their content provided further insight related to participation in hospital-based surveillance. Hospital-based infection surveillance was associated with decreased rates of central line-associated bloodstream infection (101, 102), ventilator-associated pneumonia (97, *Error! Hyperlink reference not valid.*) and SSI (99, 103). In one study, the introduction of a MRSA policy emphasizing MRSA surveillance in a neonate ICU showed that surveillance may protect non-MRSA neonates from becoming colonized (100). Introduction of an electronic surveillance system of isolation practices resulted in a small increase in isolation practices, but no changes in infection rates (104).

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this intervention. The GDG is confident that the typical values and preferences of patients, health care workers, health care providers and policy-makers would favour hospital-based infection surveillance with timely feedback and results to stakeholders and appropriate national networks.

Resource implications

The GDG is confident that the resources are worth the expected net benefit from following this recommendation. However, the GDG recognizes that its implementation is resource-intensive, particularly in LMICs. It was also noted that available human resources, microbiological/laboratory support, information technology and data management systems will have significant implications for the implementation of the recommendation. Furthermore, laboratory quality standards must be considered as these will affect the outcome of surveillance data and interpretation. Despite these potential resource implications, the GDG regards the function of

surveillance as important and going beyond the reduction of HAI. In addition, clinical HAI surveillance can be a low-cost alternative when microbiological support is not available or severely limited. The 2009 WHO Core components document (1) noted that surveillance activities are time-consuming and need to be balanced with the time needed for IPC activities.

Feasibility

While feasibility is likely to vary substantially in different settings, the GDG is confident that this recommendation can be accomplished in all countries. However, local human resource (including technical capacities) and laboratory capacity, particularly in LMICs, will need to be evaluated and addressed. Additional education will likely be required to help standardize the audit and surveillance process across all countries.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable.

Conclusions

The GDG felt very strongly that HAI surveillance is critical for evaluating and guiding IPC interventions, as well as for the detection and prevention of HAI and AMR, despite the lack of available evidence. Based on careful evaluation of the available evidence, the GDG decided to strongly recommend that facility-based HAI surveillance should be performed to guide IPC interventions and detect outbreaks, with timely feedback of results to health care workers, stakeholders and through national networks.

Research gaps

The GDG acknowledged the inconsistent application of HAI standard definitions and believed that this issue requires special attention. In addition, to help standardize HAI definitions and their application, research should be conducted to identify and test reliable alternative HAI definitions that may be more appropriate for low-resource settings, for instance, based on clinical data. More research should be conducted to assess the reliability of surveillance based on currently available patient records and data from hospital information management systems. In addition, the GDG discussed the overall lack of available evidence evaluating innovative and novel surveillance technologies, as well as improving the understanding of the role of surveillance and feedback in affecting behavioural change.

Additional implementation considerations

The GDG outlined a number of additional points to be considered in the implementation of the recommendation.

- It is important to triangulate IPC data with WASH monitoring

and services in health care facilities in effort to help identify the source of the problem; infrastructure, behaviour or both.

- In general, the HAIs selected for surveillance purposes include those that are the most preventable. In particular, the following could be prioritized:
 - › Infections that may become epidemic in the health care facility.
 - › Infections in vulnerable populations, such as neonates, burn patients, patients in ICUs and immunocompromised hosts.
 - › Infections that may cause severe outcomes, such as high case fatality and patient morbidity and suffering.
 - › Infections caused by resistant microorganisms with an emphasis on multidrug-resistant pathogens.
 - › Infections associated with selected invasive devices or specific procedures, such as the use of intravascular devices, indwelling urinary catheters and surgery, among others.
 - › Infections that may affect health care workers in clinical, laboratory and other settings (for example, hepatitis B and C).
- Several approaches to HAI surveillance exist and the scope can be facility-wide or unit-based. The most frequently used study designs are incidence and prevalence surveys. Either method has advantages and disadvantages. The former involves continuous surveillance over time and can be used to detect several infections or one specific type of infection. It has a higher sensitivity than prevalence studies and allows the timely detection of outbreaks, but it is much more resource- and time-consuming and also completely unfeasible in some settings. Prevalence surveys detect infection proportions at a specific time point (either on one day or a short period, usually of one week), but are not sensitive for the detection of outbreaks. This approach has lower sensitivity, but higher feasibility, as it is less time- and resource-consuming. Regularly repeated (for example, annually) prevalence surveys are the most frequently used approach. It is very important to adjust surveillance data according to the population case-mix and to collect data to enable stratification according to risk scores or indexes (for example, the Acute Physiology and Chronic Health Evaluation II score in critically ill patients or the US national nosocomial infections surveillance score for risk assessment in surgical patients). If adjusting for risk scores or indexes is not feasible or too labour-intensive, focusing surveillance on specific populations (for example, high risk types of surgery) or infections may be an easier way to consider confounders for the same purpose. A system for surveillance data quality assessment is of the utmost importance.
- There are many important implications associated with the interpretation of data from clinical microbiology laboratories, which can cause important biases. These include:
 - › The quality of the microbiological laboratory techniques must be assured in order to obtain valid data for clinical decisions and epidemiological use.
 - › Clinical departments and services must follow adequate procedures for the collection and transport of samples to the microbiology laboratory.
 - › Information from clinical microbiology laboratories requires analysis in order to differentiate HAI from those acquired in the community and infection from colonization, including avoiding the double-counting of cases where more than one culture has been processed.
 - › The analysis of routine data from such laboratories is usually collected for individual patient care and may generate information on the aetiology and/or patterns of AMR of the most severe infections, but not necessarily of all infections or the predominant ones.
- Reliable microbiological information is especially useful for the early detection of the pathogen concerned or a distinct emerging pattern of AMR involved in some outbreaks and the identification of the most frequent pathogens causing endemic HAI, and for understanding microbial and AMR spread. For IPC programmes, these data are essential to identify and put in place the most appropriate procedures to interrupt transmission, which may change in part, depending on the pathogen.
- Considering the lack of good quality microbiological data in many settings around the world, the GDG discussed the acceptability and reliability of surveillance based on patient clinical information (or syndromic-based surveillance). Clinical surveillance can be more easily accomplished based on clinical signs (as determined by the health care practitioner or provider) and symptoms (as reported by the patient), but it has clear limitations and does not comply with international standard definitions in most cases. Experts agreed that an important area for research is to identify and/or adapt HAI definitions based more upon clinical data and to determine their predictive value, in particular to make surveillance more feasible in low-resource settings.
- In settings that do not have access to quality laboratory services, process measurement and tracking (for example, hand hygiene compliance) may provide useful data for quality improvement.
- Innovative approaches involving patients and family carers to help detect infection signs and encourage symptom reporting should be explored or more developed. For instance, SSI very often manifests after discharge and patient reporting has the potential to add high value to surveillance.

Core component 4: Health care-associated infection surveillance

■ 4b. National level

RECOMMENDATION

The panel recommends that national HAI surveillance programmes and networks that include mechanisms for timely data feedback and with the potential to be used for benchmarking purposes should be established to reduce HAI and AMR.

(Strong recommendation, very low quality of evidence)

Rationale for the recommendation

- Evaluation of the evidence from one study shows that when HAI surveillance programmes introduce mechanisms for timely feedback in the context of a sub-national network, there is a significant reduction in HAI rates. Although they did not meet the EPOC criteria, the GDG also evaluated a number of additional articles that clearly showed the benefits of national surveillance and feedback to reduce HAIs. As a result, the GDG decided that national HAI surveillance programmes, including mechanisms for timely feedback, should be established to reduce HAI and AMR and be used for benchmarking purposes. Despite the limited evidence available, but given the importance of surveillance per se to reduce HAIs and also to guide effective IPC interventions, the GDG decided that this would be a strong recommendation based upon a very low quality of evidence. However, the GDG recognized that its implementation is resource-intensive in terms of both financial and human resources, particularly in LMICs.

Remarks

- It is important to note that in the process of agreeing on the strength of the recommendation, three GDG members were of the opinion that this recommendation should be 'conditional', while one abstained. The main concern was related not to the benefit of the intervention, but to the feasibility of implementation in all countries given the resources, the expertise and the laboratory support required.
- The GDG remarked that national HAI surveillance systems feed in to general public health capacity building and the strengthening of essential public health functions. National surveillance programmes are also crucial for the early detection of some outbreaks in which cases are described by the identification of the pathogen concerned or a distinct AMR pattern. Furthermore, national microbiological data about HAI aetiology and resistance patterns also provide information relevant for policies on the use of antimicrobials and other AMR-related strategies and interventions.
- The GDG recognized that HAI surveillance data are needed to guide the development and implementation of effective IPC interventions.
- The GDG agreed that establishing a national HAI surveillance programme requires full support and engagement by governments and other respective authorities. Moreover, this will need to include the allocation of resources, in particular, an appropriate budget, to ensure the effective coordination and sharing of available data on HAI at the country level.
- The GDG expressed that national surveillance should have clear objectives, a standardized set of case definitions, methods for detecting infections (numerators) and the exposed population (denominators) and a process for the analysis of data and reports.
- The GDG remarked that international guidelines on HAI definitions are important, but it is the adaptation at country level that is critical for implementation. Where possible, national guidelines should be developed and reference international standards and include standardized definitions and techniques for conducting surveillance. If national guidelines are not available, they should be developed. To complement these, a national training programme for performing surveillance should be established to ensure the appropriate and consistent application of national surveillance guidelines and corresponding implementation toolkits.
- The GDG noted that clear regular reporting lines of HAI surveillance data from the facility to the national level should be established.
- The GDG discussed the benefit of national HAI surveillance as part of a network using national HAI data for benchmarking and comparison.

- The GDG agreed that hospital-based infection surveillance systems need to be linked to the national surveillance system, which in turn feeds the public health infection surveillance system. In particular, the link to the national AMR surveillance system should be in place as health care facilities are considered to be high-risk settings for the selection and spread of AMR. Information regarding diseases of potential concern should be reported immediately to the public health authorities. This is in agreement with the requirements of the 2005 IHR, which have been in force since June 2007. The IHR require Member States to notify WHO of events that may constitute a public health emergency of international concern. Authorities and other public health services need efficient means of communication with national IPC programmes and other health care providers in order to disseminate knowledge, regulations, public health strategies/programmes or other information. These links are particularly important:
 - › during community outbreaks that may have an impact on health care facilities because the latter may need to care for unexpectedly large numbers of patients or because they may act as amplifiers of the outbreaks through increased risk of infection for other patients and/or health care workers;
 - › for the reporting of unusual relevant events to, from and/or between facilities, such as outbreaks or the emergence of a new pathogen or important AMR.
- The GDG highlighted the critical role of microbiology and laboratory capacity for national and hospital-based HAI and AMR surveillance. Standardized definitions and laboratory methods should be adopted. There are many important issues associated with the interpretation of data from clinical microbiology laboratories, which can cause important bias:
 - › The quality of the microbiological laboratory techniques must be assured in order to obtain valid data for clinical decisions and epidemiological use.
 - › Adequate procedures for the collection and transport of samples to the microbiology laboratory are an essential requisite to ensure quality and the national IPC programme should develop national standardized procedures to be followed at facility level.
 - › The analysis of microbiological data should produce information on the aetiology and patterns of AMR of at least the most frequent and severe infections.
- The GDG emphasized that good quality microbiological support provided by at least one national reference laboratory is a critical factor for an effective national IPC surveillance programme.
- The GDG emphasized that national surveillance HAI data are essential to assist policy-makers to prioritize and develop IPC evidence-based standards and influence decisions on appropriate antimicrobial resistance strategies and policies.

Background

IPC activities should respond to actual needs. In order to fulfill the objectives of IPC programmes, national surveillance systems for HAI, including AMR patterns, are an essential component. These will also contribute to the assessment of the impact of IPC interventions. National IPC surveillance systems feed in to general public health capacity building and the strengthening of essential public health functions.

National surveillance programmes are also crucial for the early detection of some outbreaks and new patterns of AMR. The 2009 WHO Core components document further describes a strong rationale for national surveillance systems supported by the requisite microbiology laboratory capacity and linked to national and regional public health programmes.

In a recent WHO survey (2015) on the global situational analysis of AMR, many regions have noted poor laboratory capacity, infrastructure and data management as impediments to surveillance (39). In addition, laboratory

capacity varied by country and by region. However, at least one national reference laboratory in each of the six regions was capable of testing for antibiotic sensitivity. The highest percentage of countries where organisms are tested for antibiotic sensitivity was found in the Region of the Americas (39). Although a national reference laboratory was reported by one country in each region, many did not participate in external quality assessments to ensure data quality on AMR. With the exception of two regions in which most countries reported on AMR surveillance, national reports on this topic were infrequent (39).

In this same report, AMR among rapidly growing bacteria and *Mycobacterium tuberculosis* was monitored in all regions with over 60% of respondents in each region reporting this type of surveillance. Despite regional networks supporting surveillance in many countries, none includes all the countries in its respective region (39).

Moreover, in the inventory of IPC national strategies and action plans conducted as the background for these guidelines, it was noted that most documents (79%) contain guidance related to the establishment of priorities for surveillance, despite some regional variations (web Appendix III). However, only 52% of documents address the need for standardized definitions with clear gaps in recommending surveillance in the context of outbreak response and detection.

Given the strong emphasis on surveillance, together with laboratory support and feedback, the GDG reviewed the available evidence to determine the impact of national surveillance on HAIs.

Summary of the evidence

The purpose of the evidence review (web Appendix II) was to evaluate the effectiveness of IPC programmes. One component identified was the establishment of national surveillance programmes with mechanisms for the timely feedback and benchmarking of national surveillance data with HAI as the primary outcome. One RCT (106) conducted in ICUs in a high-income country was identified.

McKinley and colleagues compared the effect of organizational level feedback on infection rates by providing risk-adjusted infection rates with and without national comparative data. Reporting local risk-adjusted infection rates to hospitals together with national comparative rates was associated with a significantly ($P < 0.001$) lower device-associated infection rate (2.2 per 1000 patient days for catheter-associated urinary tract infection, 5.5 per 1000 patient days for central line-associated bloodstream infection and 13.4 per 1000 patient days for ventilator-associated pneumonia) compared to the control group (9.0 per 1000 patient days for catheter-associated urinary tract infection, 14.0 per 1000 patient days for central line-associated bloodstream infection and 25.0 per 1000 patient days for ventilator-associated pneumonia) (106).

This study was evaluated with a high risk of bias and the GDG considered the evidence from this study as very low quality.

Non-EPOC studies

An additional 18 studies not meeting the EPOC criteria (9) were identified [11 non-controlled cohort trials (103, 107-116) and seven non-controlled before-after (85-88, 90, 117, 118)] (web Appendix II). Their findings indicated that when national surveillance programmes with mechanisms for timely feedback are introduced, there is a significant reduction in HAI rates, usually seen by surveillance programmes with a longer duration. In particular, this effect was observed in studies conducted in the following countries: (1) in Germany with SSI

(85, 87, 88), MRSA (111), ventilator-associated pneumonia (88), central line-associated bloodstream infections (88, 116) and catheter-associated urinary tract infection (86); (2) in France with SSI and multidrug-resistant organisms (107, 109, 110, 117); (3) in Italy with SSI (113); (4) in Finland with *C. difficile* (112); (5) in Switzerland with SSI (115); and (6) in the USA with overall HAI (114). Similarly, the relative risk for patients developing postoperative SSI reduced with the increased duration of a SSI surveillance programme in years 4 and 5 compared to the initial launch (90), while a mandatory SSI inpatient surveillance programme observed a reduction in inpatient SSI rates over an 8-year period (118). Likewise, when modelled for risk, a significant reduction in SSI is observed over a longer period (103).

In one additional study, using national and international datasets as comparators for benchmarking allowed national IPC programmes to identify future IPC interventions (108).

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this intervention. The GDG is confident that the typical values and preferences of patients regarding this recommendation would favour national HAI surveillance with mechanisms for timely feedback to stakeholders and appropriate national networks. Furthermore, health care providers and policy-makers are likely to place a high value on national HAI surveillance programmes within the current context of AMR, the IHR and the international communities renewed action on essential public health functions required to protect and promote population health.

Resource use

The GDG is confident that the resources required are worth the expected net benefit from following this recommendation. However, it recognized that this recommendation is resource-intensive, particularly in LMICs, and could greatly impact on the ability to ensure quality data as poor data can have the inverse effect. This recommendation will greatly depend on available human resources with the requisite skills and knowledge, microbiological/laboratory support, information technology and data management systems. Surveillance activities are time-consuming and need to be balanced with the time needed for IPC activities. In addition, education will likely be required to help standardize surveillance processes country-wide. Despite these potential challenges regarding resource implications, the GDG considers that the function of surveillance is important and it can be used to direct HAI interventions and IPC strategies.

Feasibility

Despite the fact that the available evidence is from one high-income country, the GDG is confident that this recommendation can be accomplished in all countries as the experience from high-income countries offers principles that are applicable also to LMICs.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable.

Conclusions

Despite the lack of good quality evidence, the GDG felt strongly that national HAI surveillance is critical, in particular when taking into account the current global and national actions to address AMR and the prevention of outbreaks of highly transmissible microorganisms in the context of IHR enforcement. In addition, national surveillance programmes play a role in evaluating and targeting IPC interventions. For these reasons, the GDG agreed to recommend that national surveillance programmes including mechanisms for timely feedback should be established to reduce HAIs. Moreover, the GDG suggested that national surveillance data should be used for benchmarking purposes, where possible.

Research gaps

The GDG discussed the overall lack of high-quality evidence and highlighted that additional research evaluating national HAI surveillance and its impact on HAI reduction is required. In particular, data from LMICs are lacking and research on this topic should be encouraged, including investigations about feasibility, resources needed and cost-effectiveness. The sensitivity and specificity of case definitions for each HAI needs to be addressed, in particular where microbiology laboratory access is limited or non-existent. Urgent research is needed on adapted definitions for use in settings with limited or no access to good quality microbiology support, including the optimal duration of surveillance follow-up. The reliability and usefulness of automatic surveillance is another crucial topic that deserves further investigation. Furthermore, research should include the role of HAI surveillance as part of a network effort and investigate the most optimal feedback mechanisms for a functioning national programme.

Additional implementation considerations

The GDG outlined a number of additional points to be considered in the implementation of the recommendation.

- Surveillance data should be regularly reviewed and include a method for evaluating the quality of the data. At the very least, surveillance should provide information for:
 - › Describing the status of infections associated with health care (that is, incidence and/or prevalence, type,

aetiology, severity, attributable burden of disease).

- › Identification of high-risk populations, procedures and exposures.
- › Detection of outbreaks.
- › Assessment of the impact of interventions.
- Different surveillance strategies could include the use of prevalence or incidence studies (for example, site-oriented surveillance, department-oriented surveillance or priority-oriented surveillance) and sentinel surveillance. Most systems select some relevant infections for surveillance and currently the surveillance of all infections (“total surveillance”) is rarely done. There should be a process for deciding surveillance priorities. In general, the HAIs selected for surveillance purposes include those that are preventable, especially:
 - › Infections that may become epidemic in health care facilities.
 - › Infections in vulnerable populations, such as neonates, burn patients, patients in ICUs and immunocompromised hosts.
 - › Infections that may cause severe outcomes, such as high case fatality, and infections caused by multidrug-resistant pathogens.
 - › Infections associated with selected invasive devices or specific procedures, such as the use of intravascular devices, indwelling urinary catheters and surgery, among others.
 - › Infections that may affect health care workers in clinical, laboratory and other settings.
- It is important to triangulate IPC data with WASH monitoring and services in an effort to help identify the source of the problem (that is, infrastructure, behaviour or both).
- The GDG recognised that public reporting is used in some settings and it is believed to help in transparency and data sharing. Experience from the USA using public reporting of HAI surveillance demonstrates a significant reduction in central line-associated bloodstream infections rates 13-18 months after the introduction of federal policy within states (105). However, the applicability outside of USA is unknown. In addition, the role of legislation for public reporting will need to be taken into account. The manner in which this is undertaken should be aligned with the health system and the maturity of the surveillance systems. Standardization and quality control, including the validity of the data being reported, are a matter of concern and external auditing should be implemented to ensure these. Public reporting can be a positive means to transparently inform patients and the community about important indicators of quality of care and to motivate them to participate in quality improvement initiatives. However, inappropriate or wrong interpretation or exploitation of the data can be serious risks.

- The GDG emphasized the importance of disseminating surveillance reports not only at the national level, but also regionally and locally. All relevant stakeholders should receive these reports in order to help guide, inform and evaluate IPC interventions for behaviour change, with the ultimate aim to reduce the risk of HAI and combat AMR.

Core component 5: Multimodal strategies for implementing infection prevention and control activities

■ 5a. Health care facility level

RECOMMENDATION

The panel recommends that IPC activities using multimodal strategies should be implemented to improve practices and reduce HAI and AMR.

(Strong recommendation, low quality of evidence)

Rationale for the recommendation

- Evaluation of the evidence from 44 studies shows that implementing IPC activities at facility level using multimodal strategies is effective to improve IPC practices and reduce HAI, particularly hand hygiene compliance, central line-associated bloodstream infections, ventilator-associated pneumonia and infections caused by MRSA and *C. difficile*. Multimodal strategies applied in the reviewed studies included the following components: system change; education; awareness raising; bundle-based strategies; promotion of a patient safety culture, including leadership engagement and positive reinforcement strategies; and increased accountability via monitoring and timely feedback. Due to varied methodologies and different outcomes measured, no meta-analysis was performed. As a result, the GDG decided that the implementation of IPC activities should be done using multimodal strategies in an effort to improve care practices, reduce HAI and combat AMR. The overall quality of the evidence was low given the medium to high risk of bias across studies and the varied study designs. However, the GDG unanimously decided that the strength of this recommendation should be strong.

Remarks

- The GDG deemed it important to provide standardized definitions for 'multimodal' and 'bundle' as both terms are widely used in the literature. Understanding the differences is critical for the successful implementation of the recommendation.
 - › **Multimodal strategy:** A multimodal strategy consists of several of elements or components (3 or more; usually 5) 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 5 most common components include: (i) system change (that is, availability of the appropriate infrastructure and supplies to enable IPC 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 with the establishment or strengthening of a safety climate (35).
 - › **Bundles:** A bundle is an implementation tool aiming to improve the care process and patient outcomes in a structured manner. It comprises a small, straightforward set of evidence-based practices (generally 3 to 5) that have been proven to improve patient outcomes when performed collectively and reliably (119).
- The GDG believed that successful multimodal interventions should be associated with an overall organizational culture change as effective IPC can be a reflector of quality care, a positive organizational culture and an enhanced patient safety climate.
 - › It was noted by the GDG that successful multimodal strategies include the involvement of champions or role models in several cases, that is, individuals who actively promote the components and their associated evidence-based practices within an institution. These champions have four main functions: (1) protecting those involved in implementation from organizational rules and systems that may act as barriers; (2) building organizational support for new practices; (3) facilitating the use of organizational resources for implementation; and (4) facilitating the growth of organizational coalitions in support of implementation (120).
- The GDG also noted that although the reviewed evidence was not sufficiently high quality, patient involvement could be considered as a part of establishing or strengthening the safety climate in the context of multimodal strategies. However, this approach requires local adaptation and careful consideration of the cultural specificities, social dynamics, level of education and literacy. It was emphasized that it is essential that this component involve also care attendants and family members as they often contribute to care delivery in some settings.
- The GDG emphasized that the implementation of multimodal strategies within health care institutions needs to be linked with national quality aims and initiatives, including health care quality improvement initiatives or health facility accreditation bodies (see core component 1).

Background

Over the last decade, IPC research and field implementation clearly demonstrated that behavioural change and reduction of HAI are best achieved by applying several interventions/approaches integrated within multimodal strategies. At its core, a multimodal implementation approach/strategy supports the translation of guideline recommendations into practice within health care with a view to changing health care worker behaviour. It is widely accepted that focusing on only one approach to ensure infection prevention will not achieve or sustain behaviour change. For example, in the past, the process of surveillance alone was considered the approach to employ.

In 2006, WHO developed a multimodal improvement strategy to provide users of the WHO *Guidelines on hand hygiene in health care* (35) with a ready-to-go approach to translate recommendations into practice at the facility level. This strategy was based on the best available scientific evidence and underpinned by both the long-standing expertise of the University of Geneva Hospitals (Switzerland) to promote multimodal hand hygiene promotion campaigns (121) and learning from the England and Wales National Patient Safety Agency *cleanyourhands* campaign. WHO's implementation strategy was specifically informed by the literature on implementation science, behavioural change, spread methodology, diffusion of innovation and impact evaluation. The strategy was designed to be adaptable, based on local assessments and available resources, but without jeopardizing its initial structure that intended it to be used with tailored approaches in both facilities starting a hand hygiene campaign for the first time and those with existing action on hand hygiene. The five components are: system change (focused on hand hygiene facilities at the point of patient care); training and education of health care professionals; monitoring of practices and performance feedback; reminders in the workplace; and the creation and maintenance of a safety culture with the participation of both individual health care workers, senior hospital managers and others, including patients, as appropriate. WHO's *Guide to implementation* (122) details the actions and resources necessary to ensure that each component of the multimodal strategy can become assimilated into existing infection control and quality/safety programmes. It also describes a clear need for action planning in sequential steps in order to ensure success, highlighting that the implementation of such a strategy requires commitment over a period of five 5 years (minimum).

Multimodal strategies, particularly those recommended by WHO, have been subsequently tested in a range of settings around the world. Evaluation of these strategies has

demonstrated that specific aspects contributed directly to local success. Moreover, a recent review and meta-analysis related to the multimodal hand hygiene improvement strategy showed that indeed it is the most effective approach to achieve an increase in compliance and a clinically important reduction of HAI (123).

While the bundle approach has also become both common and successful in recent years, it is important to note the differences in the definitions given here and that multimodal strategies often comprise evidence-based bundles.

Summary of the evidence

The purpose of the evidence review (web Appendix I) was to evaluate the effectiveness of IPC programmes. One component identified was the implementation of IPC activities using multimodal strategies. The primary outcome was the impact on HAI and hand hygiene compliance.

A total of 44 studies comprising 13 non-controlled before-after (44, 60, 121, 124-133), eight non-controlled cohort trials (134-141), 10 interrupted time series (40, 48, 50, 52, 95, 142-146), four qualitative (54, 120, 147, 148), three RCTs (149-151), two controlled before-after (58, 152), two mixed methods (61, 153), one non-controlled interrupted time series (154) and one stepped wedge (155) were included. Forty studies were from high-income countries (40, 48, 50, 54, 60, 61, 95, 120, 121, 124-130, 132-155), two from one upper-middle-income country (52, 58) and one from a LMIC (131).

In 27 studies, multimodal strategies showed an improvement in hand hygiene compliance among health care workers (44, 50, 54, 58, 61, 121, 125-128, 130-133, 135, 137, 138, 140, 142-144, 146, 149-153, 155). Leveraging leadership commitment and the use of opinion leaders and champions were critical components in some multimodal strategies (125, 128, 143, 147, 150, 152, 155). Four studies used positive reinforcement to health care workers when correctly performing hand hygiene as one element of their strategies (142, 151) by applying principles of product marketing to encourage staff to choose their own intervention (130) and offering financial incentives to hospital units or wards for high-level hand hygiene performance (146). Accessibility to handrub, role models, a personal sense of responsibility and emotional involvement were some factors identified as barriers affecting hand hygiene compliance (54).

Nine studies investigated the role and effectiveness of multimodal strategies in reducing catheter-related and central line-associated bloodstream infection. Eight were quantitative studies conducted in intensive care (48, 60, 129, 134, 139, 141, 145, 154) and one was a qualitative study

reporting factors influencing behavioural change in the context of peripheral venous line use (147). All intervention studies used a multimodal approach, including the use of bundles or comprehensive procedures, defined and promoted at various levels. These were senior manager commitment and support, training, identification of champions or leads and the provision of additional materials and equipment. Three studies focused primarily on catheter insertion (129, 139, 154), 3 addressed catheter insertion and maintenance (134, 145), and one focused on catheter care (60). All 8 quantitative studies showed a reduction in central line-associated bloodstream infection rates (48, 60, 129, 134, 139, 141, 145, 154). Four studies also provided data about process indicators (60, 128, 141, 154).

Three studies addressed ventilator-associated pneumonia. They showed that multimodal prevention strategies are successful in reducing ventilator-associated pneumonia rates (52, 128, 156), in particular when the programme is developed by a multidisciplinary task force, processes are closely monitored (124), all relevant stakeholders are engaged using a well-structured business plan (128) and with the inclusion of a strong educational component for frontline health care workers (52).

In three studies, multimodal strategies were associated with overall reductions in MRSA (95, 136) and *C. difficile* (40) infections. MRSA infection rates were reduced by the use of bundle-based strategies (95, 136). Among the latter, one used the principles of positive deviance to achieve culture change, making infection control the responsibility of every stakeholder in addition to introducing MRSA managers at every hospital, MRSA screening, contact precautions and promotion of hand hygiene among health care workers (136). Almost all included studies (42) were performed in high-income/upper-middle-income countries only. The GDG considered the overall quality of the evidence as low given the medium to high risk of bias across studies and the varied study designs outside the recommended EPOC study designs (9).

Non-EPOC studies

An additional 91 studies comprising 69 non-controlled before-after (47, 75, 157-223), 21 non-controlled cohort trials (224-244) and one case-control study (245)] were retrieved (web Appendix I). Although they did not meet the EPOC criteria (9), they provide further support for implementing IPC activities using multimodal strategies as described above.

In 27 studies, multimodal strategies were shown to help improve hand hygiene compliance (47, 75, 158, 161-163, 165, 167, 177, 178, 180, 183, 185, 187, 191, 195, 196, 198, 199,

206, 207, 209, 211, 213, 220, 232, 245). Multimodal strategies catalysing education, system change, surveillance and feedback were associated with reductions in catheter-related bloodstream infection (159, 170, 216, 239), MRSA (111, 180, 202, 212), catheter-associated urinary tract infection (178, 183, 199, 203, 223), ventilator-associated pneumonia (188, 218, 231, 235) and central line-associated bloodstream infection (190, 217, 219) rates. In one study, a practice development framework (multidisciplinary team, clinical assessments, practice checklists, guideline development and education) was associated with a decrease in catheter-related bloodstream infection (222).

Bundles used as stand-alone interventions or as part of multimodal strategies were associated with decreased rates of central line-associated bloodstream infection (164, 169, 172, 176, 181, 182, 189, 201, 204, 226, 228, 229, 233, 234, 241, 242), VAP (157, 160, 164, 171, 194, 197, 200, 214, 237, 238, 240), SSI (179, 224, 243), catheter-associated urinary tract infection (166, 174), catheter-related bloodstream infection (208) and MRSA (168).

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this intervention. The GDG is confident that health care providers, health care workers, policy-makers and patients in all settings are likely to place a high value on multimodal strategies that have the potential to reduce HAI and AMR and, importantly, improve patient outcome and protect the health workforce.

Resource implications

The GDG is confident that the resources required are worth the expected net benefit from following this recommendation. However, the GDG recognizes that some resource implications depend on the multimodal strategy and the target population involved. Resources may be needed from multiple sources to implement a multimodal strategy, requiring coordination and teamwork across the organization or health facilities. Moreover, technical expertise is required for overall coordination and programme development, which may pose some difficulties in LMICs.

Feasibility

The GDG is confident that this recommendation with the potential for adaptation to the local context can be accomplished in all countries, while acknowledging that the presence of an IPC programme should be taken into consideration prior to implementing multimodal strategies,

including the current context of the organizational culture of the health facility, and, in some instances, the community as well.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable.

Conclusions

Following careful evaluation of the available evidence, the GDG recommends implementing IPC activities using multimodal strategies to improve practices and reduce HAIs and combat AMR.

Research gaps

The GDG discussed the need for further research to determine which elements of multimodal strategies are most effective and what other elements should be considered in addition to the recognized 5 components. Furthermore, the panel expressed that better quality studies will be needed when investigating components of multimodal strategies and their impact on HAIs. Stepped-wedge cluster randomized studies could represent the most appropriate methodological approach to answer this question. It would also be interesting to better understand the type of (multi-)professional expertise necessary for implementing successful multimodal strategies and to identify the key staff members driving these interventions, depending on the setting. Qualitative research to understand the factors facilitating success and the barriers and challenges to implementation is also considered to be of the utmost importance, given the complex implementation of these interventions.

Additional implementation considerations

The GDG outlined the following additional point to be considered in the implementation of the recommendation.

- The GDG noted that although the reviewed evidence was not sufficiently high quality, patient involvement could be considered as a part of establishing or strengthening the safety climate in the context of multimodal strategies. However, this approach requires local adaptation and careful consideration of the cultural specificities, social dynamics, level of education and literacy. It was emphasized that it is essential that this component involve also care attendants and family members as they often contribute to care delivery in some settings.

Core component 5: Multimodal strategies for implementing infection prevention and control activities

■ 5b. National level

RECOMMENDATION

The panel recommends that national IPC programmes should coordinate and facilitate the implementation of IPC activities through multimodal strategies on a nationwide or sub-national level.

(Strong recommendation, low quality of evidence)

Rationale for the recommendation

- Evaluation of the evidence from 14 studies shows that the national roll-out of multimodal strategies is associated with reductions in central line-associated bloodstream infections, MRSA infections and increased hand hygiene compliance. By contrast, no significant difference in SSI rates was observed. Due to varied methodologies and different outcomes measured, no meta-analysis was performed. As a result, the GDG decided to recommend that IPC activities should be implemented under the coordination and facilitation by the national IPC programme using multimodal strategies in an effort to improve care practices and reduce HAI and combat AMR. The overall quality of the evidence was low given the medium to high risk of bias across studies. However, the GDG unanimously decided that the strength of this recommendation should be strong given the relatively good number of national studies identified and the conviction that multimodal strategies are an innovative and effective approach not only to reduce HAIs, but also to achieve broader patient safety improvement.

Remarks

- The GDG noted that the purpose of the recommendation is to support facility level improvements by ensuring that national level support and coordination are in place.
- The terms ‘multimodal’ and ‘bundle’ refer here to the definitions discussed and agreed by the GDG, which are reported in section 5a describing this core component at the facility level.
- The GDG agreed that the national approach to coordinating and supporting local (health facility level) multimodal interventions should be within the mandate of the national IPC programme (see core component 1) and be considered within the context of other quality improvement programmes or health facility accreditation bodies. Ministry of health support and the necessary resources (including policies, regulations and tools) are essential for effective central coordination. This recommendation is to support facility level improvement.
- The GDG did remark that not all IPC interventions require multimodal strategies and, in some cases, more targeted, direct approaches for improvement are needed. The desired outcomes need to be well understood in order to design the best and most appropriate approach.
- The GDG recognized that while most studies did not mandate nationwide participation and in fact some were voluntary, the vast majority had sample sizes that would indicate representation at the “national” level.
- The GDG emphasized that strong consideration should be given to country adaptation of implementation strategies reported in the literature, as well as to the feedback of results to key stakeholders and education and training to all relevant persons involved in the implementation of the multimodal approach.
- The GDG believed that successful multimodal interventions should be associated with overall cross-organizational culture change as effective IPC can be a reflector of quality care, a positive organizational culture and an enhanced patient safety climate.

Background

A national approach in support of the implementation of multimodal IPC improvement efforts is recognized as having key benefits in comparison to localized efforts alone. For the purposes of this work, “national” was considered to embrace both national and/or subnational (for example, state-wide) activity. As an example, one of the 9 recommendations of the WHO *Guidelines on hand hygiene in health care* issued

in 2009 (35) emphasized a nationally coordinated approach to support the implementation of multimodal hand hygiene improvement strategies. Lessons from multiple countries in hand hygiene improvement efforts based on the WHO guideline recommendations suggest that a multimodal approach can be used for other IPC areas. In many cases, hand hygiene has been considered to be the “entrance door”

to broader safety and quality improvement. In addition, a number of countries have implemented the WHO *Core components* document (2009), which in itself represents a multifaceted approach to improvement.

There have been important lessons learned on the role of national level support for the implementation of such multifaceted interventions. Many countries have also initiated patient safety programmes nationally within which IPC core components have been included, as evidenced in this review (246-248). Other examples include Australia's development of a national hand hygiene initiative and national safety and quality health service standards (hospital accreditation standards) (249).

Parallels from national and sub-national hand hygiene campaigns can also yield insights into the factors for success and sustainability. In particular, a number of studies in this area recognized the need for financial and human resources as predominant reasons for successful nationally-coordinated approaches.

The use of care bundles has also become common in recent years as part of national evidence-based improvement programmes. However, as already noted, bundles have been recognized as only one component of a multimodal strategy.

Summary of the evidence

The purpose of the evidence review (web Appendix II) was to evaluate the effectiveness of IPC programmes. One component identified was the implementation of IPC activities using multimodal strategies. The primary outcome was the impact on HAI and hand hygiene compliance.

A total of 14 national or subnational studies comprising seven interrupted time series (136, 248, 250-254), four controlled before-after (133, 255-257), two RCTs (151, 258) and one non-RCT (259)] were included, all from high-income countries (133, 136, 151, 248, 250-259). The elements within the national multimodal strategies varied, but they were evaluated as a collective whole. The number of elements ranged from two to eight with the most frequently cited elements being the implementation of a care bundle with the provision of training and campaign materials to support the implementation (133, 136, 151, 250, 251, 255-259).

Three studies investigated the effectiveness of multimodal strategies in reducing central line-associated bloodstream infection and showed a reduction in infection rates post-intervention (250, 258, 259). In all studies, the introduction of a central line-associated bloodstream infection care bundle (250, 258, 259) was accompanied by other components,

including targeted training and supportive materials (250, 258, 259), organizational culture change and executive support (258, 259), surveillance (259), posters and other promotional campaign materials (250). Conversely, in one study measuring the impact of a state-wide SSI multimodal strategy, no improved surgical outcomes were observed during the study period (256).

In three studies, a significant reduction in infection rates was observed following the introduction of a central line-associated bloodstream infection care bundle only, targeting insertion and maintenance care practices in paediatric ICUs (252-254). In one study, the rate of MRSA SSI decreased during the intervention period for the SSI care bundle for both orthopaedic and cardiac operations (248).

One study evaluated the effectiveness of a collaborative quality improvement strategy on HAI in neonatal ICUs in the USA (257). The interventions focused on the prevention of central line-associated bloodstream infection by introducing a care bundle, targeted training and additional complementary training materials. After risk adjustment, the quality improvement strategy was significantly associated with a reduction in HAI (positive blood cerebrospinal fluid culture) for the evaluation period (257).

In one study, a state-wide multimodal programme that showed reductions in catheter-related bloodstream infections and ventilator-associated pneumonia using a care bundle comprising elements for cultural change, training and teamwork and communication was investigated for its impact on mortality and length of stay (255). Reductions in mortality were associated with the implementation of the multimodal programme at both 1 and 2 years' post-implementation. However, no significant difference for adjusted length of stay was observed between groups (255).

Two studies explored the effect of a national multimodal IPC programme to reduce MRSA (136, 251) infections. The rate of MRSA colonization or infection declined with the implementation of MRSA screening, culture change, training and funding (136). A significant downward trend in MRSA bacteraemia rates was associated with the implementation of a recent national multimodal IPC programme that used improved provision of alcohol-based handrubs, performance feedback to health care workers, posters and other campaign materials and policy reviews (251).

Implementation of national multimodal programmes on hand hygiene practices led to mixed results. In one Australian study, both compliance and HAI rates were measured after the implementation of a state-wide hand hygiene campaign

based on the improved provision of alcohol-based handrubs, posters and other campaign materials and identified leads. The results showed a significant impact on two out of four clinical indicators of MRSA infection, but the authors recognized that these might have been also influenced by other IPC interventions (133). Conversely, in a national multimodal hand hygiene programme using targeted training and other supportive materials, improved provision of alcohol-based handrub and performance feedback to health care workers, there was an estimated average change in 'any hand hygiene compliance' in intervention hospitals when compared to control hospitals (151).

The GDG agreed to consider the overall quality of evidence as low given the medium to high risk of bias across studies. However, the group unanimously decided that this remains a strong recommendation. All studies (14) were performed in high-income countries only and, therefore, generalizability is uncertain or limited with regards to applicability outside of these settings.

Non-EPOC studies

An additional 48 studies comprising 33 non-controlled before-after (158, 175, 183, 231, 239, 247, 260-285), 14 non-controlled cohort trials (31, 284, 286-296) and one qualitative study (297)] were retrieved (web Appendix II). Although these provide further support for implementing national level IPC activities using multimodal strategies and care bundles, the studies are not included in the overall analysis as they did not meet the study design types recommended by the EPOC group (9).

In five studies, multimodal strategies were shown to help improve hand hygiene compliance (158, 261-263, 273, 283).

Bundles used as stand-alone interventions or as part of a multimodal strategy were associated with decreased rates of ventilator-associated pneumonia (231, 268, 274-277, 284, 288, 296), central line-associated bloodstream infection (265-267, 280, 281, 285, 287, 293, 298), SSI (31, 264, 279, 292, 295), catheter-related bloodstream infection (239, 270-272), bloodstream infection (247, 260) and catheter-associated urinary tract infection (183, 294) When paired with a broader safety programme initiative including care practice checklists, education tools promoting increased communication, teamwork and feedback of data, a decrease in central-line days (282) and central line-associated bloodstream infections (287) was observed. In one study, a hand hygiene initiative in conjunction with education and feedback across 6 states was associated with a decrease in bloodstream infection rates in four states (260).

In four studies, reductions in MRSA transmission and infections were associated with the introduction of a quality improvement MRSA prevention programme (289, 291), a *cleanyourhands* campaign (278) and a national IPC programme including national guidelines and regulations, training programmes and national level surveillance (31). The implementation of a carbapenem-resistant *Enterobacteriaceae* preventative programme was associated with a decrease in the prevalence of carbapenem-resistant *Enterobacteriaceae* prevalence and increased compliance with IPC standards (286).

A pronounced downward trend of *C. difficile* incidence rates was observed with the use of standardized clinical infection prevention and environmental cleaning protocols, including monitoring with checklists (290).

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this intervention. The GDG is confident that the typical values and preferences of health care providers, policy-makers and patients regarding the outcome would favour this intervention.

Resource implications

The GDG is confident that the resources required are worth the expected net benefit from following this recommendation. However, the GDG recognizes that the resources to action this recommendation (that is, human resources, IPC expertise, the expertise of social scientists, support services, tools and budgets, and leadership commitment) may be a challenge in some LMICs. In some instances, partnerships or collaborations could assist in the achievement of programme delivery and funding, such as the WHO African Partnerships for Patient Safety model.

One cost-effectiveness study estimated the cost of a central line-associated bloodstream infection at US\$ 18 793 per patient, while the cost of the quality improvement programme was approximately US\$ 540 per patient (299). Another study estimated a cumulative saving of 509 000 *C. difficile* infection cases and 82 000 *C. difficile*-attributable deaths averted with cost-savings of US\$ 2.5 billion (US\$ 1.2-4 billion) through the implementation of a multifaceted *C. difficile* IPC programme (300).

Feasibility

The GDG is confident that this recommendation can be accomplished in all countries, acknowledging that the presence of an IPC programme should be taken into

consideration prior to implementing multimodal strategies, as well as the cultural context and impact on the acceptability of national approaches to multimodal strategies.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable.

Conclusions

The GDG recognized that the evidence is of low quality, but it decided that this should be a strong recommendation. The purpose of the recommendation is to support facility-level improvements by ensuring that national level support and coordination is in place. The GDG also believed that the national approach should be within the context of national IPC programmes and could be considered as part of a wider quality improvement agenda. Therefore, the GDG recommended that national IPC programmes should coordinate and facilitate the implementation of IPC activities through multimodal strategies on a nationwide or sub-national level to improve practices and reduce HAIs and AMR spread.

Research gaps

The GDG discussed the need for further research on what is required to facilitate sustainable national implementation and roll-out. Research into the impact of culture and context in relation to national approaches to multimodal strategies were also highlighted. In addition, well-designed cost-effectiveness studies, together with impact evaluation studies, were recommended.

Additional implementation considerations

The GDG outlined the following additional points to be considered in the implementation of the recommendation.

- The GDG was of the opinion that information technology and data management support will be critical to the central coordination of national multimodal strategies, especially for assisting the regular reporting and evaluation of the strategies and IPC programmes.
- The GDG noted that it was not possible to always separate the difference between the impact of care bundles and multimodal approaches. Therefore, it was suggested that care bundles could be embedded in multimodal strategies, when appropriate.

Core component 6: Monitoring/audit of IPC practices and feedback and control activities

■ 6a. Health care facility level

RECOMMENDATION

The panel recommends that regular monitoring/audit and timely feedback of health care practices according to IPC standards should be performed to prevent and control HAI and AMR at the health care facility level. Feedback should be provided to all audited persons and relevant staff.

(Strong recommendation, low quality of evidence)

Rationale for the recommendation

- Evaluation of the evidence from six studies shows that the regular monitoring/auditing of IPC practices paired with regular feedback (individually and/or team/unit) is effective to increase adherence to care practices and to decrease overall HAI. Due to varied methodologies and different outcomes measured, no meta-analysis was performed. As a result, the GDG decided that audits and timely feedback of health care practices according to IPC standards should be performed regularly for the prevention and control of HAI and AMR. The overall quality of evidence was low given the medium to high risk of bias across studies and the varied study designs. However, the GDGs unanimously decided that the strength of this recommendation should be strong when considering the importance of the monitoring and feedback of IPC practices to demonstrate existing gaps and achieve health care workers' behavioural change towards good practices.

Remarks

- The main purpose of auditing/monitoring practices and other indicators and feedback is to achieve behavioural change or other process modifications to improve the quality of care and practices with the aim of reducing the risk of HAI and AMR spread. The GDG emphasized the importance of sharing the audit results and providing feedback not only with those being audited (individual change), but also with hospital management and senior administration (organizational change). IPC teams and committees (or quality of care committees) should also be included as IPC care practices are quality markers for these programmes. Monitoring and feedback are also aimed at engaging stakeholders, creating partnerships and developing working groups and networks.
- Another crucial aspect discussed by the GDG was the evaluation of IPC programmes (Core component 1). There was strong consensus that IPC programmes should be periodically evaluated to assess the extent to which the objectives are met, the goals accomplished, whether the activities are being performed according to requirements and to identify aspects that may need improvement identified via standardized audits. Evaluation should be based on the documentation of the impact in terms of defined outcomes. Important information that may be used for this purpose includes the results of the assessment of compliance with IPC practices (as outlined by technical guidelines; see core component 2), other process indicators (for example, training activities), dedicated time by the IPC team and resource allocation.

Background

IPC interventions require the consistent practice of preventive procedures, such as hand hygiene, respiratory hygiene, use of surgical antimicrobial prophylaxis and the aseptic manipulation of invasive devices, and many others. The appropriateness with which these procedures are performed depends on individual health care workers' behaviour and the availability of appropriate resources and infrastructures. In order to identify deviations from requirements and to improve performance and compliance, the frequent assessment

of working practices is necessary by using standardized auditing, indicator monitoring and feedback.

The auditing process is a quality improvement process that seeks to improve patient care and outcomes through a systematic evaluation of care against explicit criteria and the implementation of change. Wherever indicated, these changes are implemented at an individual, team or service level and further monitoring is used to confirm improvement

in health care delivery (301). It is important to note that this quality improvement process should be done in a blame-free manner to promote a non-punitive institutional culture.

In addition, how these results and findings are communicated and shared are equally important to the process itself. Regular monitoring, evaluation and reporting of IPC outcomes and care practices should be shared with the immediate stakeholders, but also those in higher positions who have the ability to act and support change across the organization. Understanding the role of auditing and feedback and its impact on HAI remains unclear, but it is extremely important.

Summary of the evidence

The purpose of the evidence review (web Appendix II) was to evaluate the effectiveness of IPC programmes. One component identified was the audit of IPC practices and timely feedback to all relevant staff at the facility level. The primary outcomes were HAI and hand hygiene compliance. A total of six studies comprising one RCT (302), two controlled before-after (303, 304), one interrupted time series (95) and two non-controlled before-after (305, 306) were included. Five were from high-income countries (95, 302, 304-306) and one from an upper-middle-income country (303).

Daily audits of adherence to bundle strategies coupled with regular feedback have been shown to reduce rates of ventilator-associated pneumonia (305) and MRSA acquisition (95). Predefined process indicators for catheter insertion improved with periodic auditing and personalized feedback (302). Peer assessments with anonymous feedback effectively improved universal precaution measures (303) and the use of a comprehensive checklist covering a wide range of care practices reduced the prevalence of all HAI (304). Furthermore, cases of bacteraemia caused by coagulase-negative staphylococci were reduced by internal audits on hand hygiene and catheter-hub care in neonates (306).

The GDG considered the evidence as low quality given the medium to high risk of bias across studies according to the EPOC criteria (9) and the varied study designs.

Non-EPOC studies

Only one additional study [non-controlled before-after trial (307)] not meeting the EPOC study design criteria was retrieved (web Appendix II) and provided further support for periodic audits and timely feedback of IPC practices. In this study, Armellino and colleagues demonstrated that remote video auditing and feedback (visual cues and electronic reports) were associated with a significant increase in hand hygiene compliance compared to remote video auditing alone.

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this intervention. The GDG is confident that the typical values and preferences of patients regarding the outcome would favour a regular evaluation of IPC practices in an effort to gauge implementation and, subsequently, support future improvement in the quality of care provided. In addition, health care providers, policy-makers and the health workforce are likely to place a high value on routine monitoring and feedback as part of a multifaceted IPC programme.

Resource implications

The GDG is confident that the resources necessary are worth the expected net benefit from following this recommendation. However, the GDG recognizes that the auditing process will require dedicated time and additional human resources in order to achieve meaningful, accurate evaluation of IPC practices in some cases. Reliable auditing requires also the specific and appropriate training of assessors. This expertise is usually limited or unavailable in low-resource settings, but it is essential to offer this training in order to collect reliable data.

Feasibility

The GDG is confident that this recommendation can be accomplished in all countries, although further education regarding audits may be required to help standardize this process. Moreover, the panel acknowledged that the auditing process should be undertaken with care and sensitivity, promoting a non-punitive, blame-free environment. A good approach to start auditing activities is crucial for the future success of the programme. For each facility, the approach should be adapted to the existing situation and context.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable.

Conclusions

Following careful evaluation of the available evidence, the GDG recommends a regular audit and timely feedback of health care practices according to IPC standards for the prevention of HAI and AMR spread. Feedback should be provided to all audited persons and relevant staff.

Research gaps

The GDG remarked that there is a general lack of available published standards for other aspects beyond hand hygiene

in the available evidence. Although hand hygiene is very important, other critical aspects need to be explored, such as catheter-related bloodstream infection, ventilator-associated pneumonia, catheter-associated urinary tract infection, environmental cleaning and disinfection and other infection markers reflective of the health facility context. Furthermore, the panel agreed that more innovative, reliable methods of monitoring should be explored beyond traditional approaches, for example, electronic and/or infrared.

Additional implementation considerations

The GDG outlined the following additional points to be considered in the implementation of the recommendation.

- It was noted that the auditing of cleaning procedures is often neglected and should instead be prioritized with performance feedback given to cleaners as an important part of the frontline team.
- The GDG agreed that IPC monitoring should encourage improvement and promote learning from experience in a non-punitive institutional culture, thus contributing to better patient care and quality outcomes.

Core component 6: Monitoring/audit of IPC practices and feedback and control activities

■ 6b. National level

RECOMMENDATION

The panel recommends that a national IPC monitoring and evaluation programme should be established to assess the extent to which standards are being met and activities are being performed according to the programme's goals and objectives. Hand hygiene monitoring with feedback should be considered as a key performance indicator at the national level.

(Strong recommendation, moderate quality of evidence)

Rationale for recommendation

- Evaluation of the evidence from one study shows that national feedback of IPC monitoring data is effective to increase adherence to care practices and to decrease overall HAI. Despite the limited evidence, the GDG agreed that monitoring and evaluation should be an activity driven and coordinated by the national IPC programme and that this would be a strong recommendation based on a moderate quality of evidence. The panel also proposed that hand hygiene be considered as a key indicator for all national IPC programmes.

Remarks

- The GDG recognized that monitoring and evaluation provides a systematic method to document the impact of national programmes in terms of defined indicators, for example, tracking hand hygiene improvement as a key indicator, including hand hygiene compliance monitoring. The GDG felt strongly that the regular monitoring, evaluation and reporting of IPC outcomes, processes and strategies should occur at the national level and within health care facilities. Monitoring and evaluation should be performed to assess the extent to which standards are being met, goals accomplished and activities performed according to requirements and to identify aspects that may need improvement. This includes regular evaluation of compliance with regulations, as well as compliance with clinical practice standards.
- The GDG supported the recommended approach to national level monitoring and evaluation as described in the WHO Core components document (2009), which highlighted having in place mechanisms that:
 - Provide regular reports on the state of national goals (outcomes and processes) and strategies.
 - Regularly monitor and evaluate the WASH services, IPC activities and structure of the health care facilities through audits or other officially recognized means.
 - Promote the evaluation of the performance of local IPC programmes in a non- punitive institutional culture.

Background

Monitoring and evaluation of national programmes is important in relation to tracking the effectiveness of national policies and strategies, including providing critical information to support implementation and future development and improvement. National IPC programmes, policies, strategies and plans are part of a process designed to contribute to improving the quality of health care of all people. Therefore, they must align with other national priorities associated with the achievement of the health-related United Nations SDGs, particularly the achievement of quality health service delivery in the context of universal health coverage. National IPC programmes and policies also contribute to the achievement of the IHR and the global reduction in AMR. Monitoring the effectiveness of these programmes, policies and strategies is therefore highly important.

In a recent WHO survey of national IPC documents across all WHO regions, on average, 72% addressed the need for both national and facility level monitoring and evaluation (range: 56% in the Western Pacific Region to 86% in the South-East Asia Region (web Appendix III)). National monitoring and evaluation is therefore currently being utilized as one approach to determine the effectiveness of IPC programmes, although details on specific approaches are not available.

A national approach to monitoring and evaluation ultimately serves to provide centralized data to improve future implementation activity and ensure that policies and strategies are effective.

Summary of the evidence

The purpose of the evidence review (web Appendix II) was to evaluate the effectiveness of IPC programmes. One

component identified was establishing monitoring and feedback systems at the national level. The primary outcome was hand hygiene compliance or any other process or infrastructure indicators.

One RCT (149) exploring the effectiveness of providing feedback of national hand hygiene compliance data in acute care settings for elderly patients and in ICUs (149) was identified. In this study, Fuller and colleagues tested the hypothesis that a behavioural designed feedback intervention would produce a significant sustained improvement in hand hygiene compliance compared to routine practice (149). Feedback was provided to individual health care workers whose hand hygiene practices had been observed at ward meetings. The study found that the odds ratio for hand hygiene compliance was higher in both of the acute care (of the elderly) wards as a result of providing feedback on hand hygiene behaviour (149). This study was evaluated with an overall low risk of bias.

The GDG considered the overall evidence from this study as moderate quality.

Non-EPOC studies

One additional study was retrieved [non-controlled before-after trial (308)] that supports the inclusion of hand hygiene as a key indicator for monitoring and providing timely feedback. McGuckin and colleagues investigated the impact of a 12-month multicentre collaboration assessing hand hygiene compliance monitoring of product usage in health care facilities in the USA combined with feedback about hand hygiene compliance. A significant increase in hand hygiene compliance was observed from 26% for ICUs and 36% for non-ICUs to 37% and 51%, respectively (308).

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this intervention. The GDG is confident that the typical values and preferences of patients regarding the outcome would favour a national hand hygiene monitoring programme that included shared feedback to help drive improvements at the national, district and local level. It is highly likely that policy-makers and health providers will place a high value on national approaches to monitoring and evaluation since such an approach has the potential to increase user confidence that IPC is being taken seriously as a key public health issue.

Resource implications

The GDG is confident that the resources are worth the expected net benefit. However, the GDG recognizes that in some instances, the monitoring and personalized feedback of IPC indicators will require dedicated time and additional human resources in order to achieve a meaningful, accurate evaluation of IPC practices. Electronic systems to undertake audits, which are becoming increasingly widely available in particular for hand hygiene monitoring and do result in a need for additional resources, are not covered within this chapter.

Feasibility

The GDG is confident that this can be accomplished in all countries, while acknowledging that the establishment of national monitoring and evaluation systems, including hand hygiene monitoring, requires an in-place and functional national IPC programme. Further education regarding hand hygiene monitoring may be required to help standardize the process locally and nationally. Moreover, the panel suggested that the monitoring process should be undertaken with care and sensitivity, taking account of patients and promoting a non-punitive, blame-free environment to nurture staff improvement.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable.

Conclusions

Following careful evaluation, the GDG recommended that a national approach to monitoring and evaluation should be established with a focus on hand hygiene monitoring as a key indicator in the context of a national IPC programme.

Research gaps

Despite the numerous examples of existing national approaches to monitoring and evaluation, the GDG remarked that a lack of available published evidence remains, especially high quality data. Critical aspects that need to be explored include the availability of WASH services and the impact on IPC practices other than hand hygiene and other IPC outcomes, such as the audit mechanism against catheter-related bloodstream infection, ventilator-associated pneumonia, catheter-associated urinary tract infection and other relevant infection standards and interventions reflective of the health facility context. Furthermore, the panel agreed that more innovative methods of monitoring should be explored beyond traditional approaches, for example, electronic and/or infrared.

Additional implementation considerations

The GDG outlined the following additional point to be considered in the implementation of the recommendation.

- The GDG acknowledged that monitoring should include a variety of frameworks of which one should be self- or peer-evaluation against national standards or goals. Regarding hand hygiene performance monitoring and feedback, the GDG suggested the use of the WHO hand hygiene self-assessment tool across all facilities as a minimum requirement. The reporting of results should be shared at the national level as a benchmarking approach, as well as at the facility level, including hospital management and senior administration. Ideally, regular hand hygiene compliance monitoring according to the WHO method should also be a requirement mandated by the national IPC programme, at least for reference hospitals in the country.

Core component 7: Workload, staffing and bed occupancy at the facility level

RECOMMENDATION

The panel recommends that the following elements should be adhered to in order to reduce the risk of HAI and the spread of AMR: (1) bed occupancy should not exceed the standard capacity of the facility; (2) health care worker staffing levels should be adequately assigned according to patient workload.

(Strong recommendation, very low quality of evidence)

Rationale for the recommendation

- Evaluation of the evidence from 19 studies shows that bed occupancy exceeding the standard capacity of the facility is associated with the increased risk of HAI in acute care facilities, in addition to inadequate health care worker staffing levels. No meta-analysis was performed due to the different methodologies and the different outcomes measured. The GDG unanimously decided to recommend adherence to bed occupancy not exceeding the standard capacity of the facility and adequate health care worker staffing levels according to patient workload in order to reduce the risk of HAIs and spread of AMR. The overall quality of the evidence was very low, but the GDG unanimously decided that the strength of this recommendation should be strong due to the importance of these topics not only for reducing the risk of HAI but for improving the quality of health care delivery and achieving quality universal health coverage.

Remarks

- The GDG considered the standard for bed occupancy to be one patient per bed and that this should not be exceeded. This is in direct support of the WHO standard on facility design, recommending one patient per bed with adequate spacing (1 metre) between patients (25, 32).
- The GDG acknowledged that intended bed capacity could vary from original designs and across facilities and countries. For these reasons, it was proposed that ward design regarding bed capacity should be adhered to and in accordance with national and international standards. In exceptional circumstances where bed capacity is exceeded, hospital management should act to ensure appropriate staffing levels that meet patient demand and the adequate distance between beds. The GDG considered that these principles apply to all units and departments with inpatient beds, including emergency departments, while the evidence reviewed is related to general wards only.
- Overcrowding was recognized as being a public health issue that can lead to disease transmission. The GDG further noted that the volume of visitors, especially in some countries where they contribute to care delivery, could become a potential contributing factor to disease transmission in some circumstances.
- The WHO *Workload Indicators of Staffing Need* method provides health managers with a systematic way to determine how many health workers of a particular type are required to cope with the workload of a given health facility and aid decision-making (309).
- The GDG noted that workload might vary during outbreak situations and influence the needs for or the availability of care personnel. In addition, it was also noted that patient's visitors/relatives might assume care activities in some situations.
- The GDG also recognized that in special circumstances, adherence to this recommendation may need to be balanced against the immediate need to provide clinical care to as many patients as possible.

Background

A combination of factors should be considered when determining the patient-to-bed ratio and the health care worker-to-patient ratio, including patient acuity, health care demand and availability of the health workforce. These factors can raise challenges regarding the intended versus designed hospital bed capacity, which could potentially lead to increased rates of HAI and spread of AMR if not

complemented with an appropriate health care worker staffing level. Overcrowding in health care facilities is recognized as being a public health issue that can lead to disease transmission. Understanding these factors and to what extent they influence patient outcomes and impact on health care worker practices will be important in creating an enabling environment for the delivery of safe, high quality and people-centred care.

Summary of the evidence

The purpose of the evidence review (web Appendix I) was to evaluate the impact of appropriate bed occupancy standards and the balance of health care worker staffing to patient workload on HAI and hand hygiene compliance.

A total of 19 studies comprising 12 non-controlled cohort (310-321), three case-control studies (322-324), one interrupted time series (325), one non-controlled interrupted time series (326), one mixed methods (327) and one cross-sectional (328) trial were retrieved through the SIGHT review (2) and none through its update. Studies were all from high-income countries. MRSA transmission and infection were associated with bed occupancy in six studies (312-315, 325, 329) and the nurse-to-patient ratio in seven studies (311, 318, 321-323, 326, 327). Three studies reported that increases in nurse-to-patient ratios resulted in reduced HAI (316, 317, 319), while inadequate adherence to hand hygiene protocols was associated with low staffing levels in one study and with high workload in another (320, 328).

The quality of the evidence was graded as intermediate according to the ICROMS criteria used in the SIGHT review (2). However, given that most of these publications were not intervention studies and do not meet the EPOC recommended study designs criteria (9), the GDG considered this evidence as very low quality.

Additional factors considered when formulating the recommendation

Values and preferences

No study was found on patient values and preferences with regards to this recommendation. The GDG agreed that patients in all settings are likely to place a high value on both adequate staffing levels and the ability to access a bed in order to reduce their risk of HAI and of AMR acquisition and would support this recommendation to ensure safe care. However, the GDG did recognize that in some settings, adherence to this recommendation might be influenced by patient opinion. Patients may feel that they would still like to receive care in an overcrowded facility if this is the only option available. While understanding that such situations can exist, populations should be aware that this is unacceptable from a safety perspective. In addition, it does not support quality in the context of universal health coverage and violates a basic human right. Furthermore, policy-makers, health care providers and the health workforce are likely to place a high value on having sufficient capacity and an infrastructure that facilitates safe service delivery.

Resource implications

The GDG is confident that this recommendation can be implemented in all countries in the long term and that the resources required will be worth the net benefit, despite the costs incurred. There is a need for institutions to provide the necessary resources in order to meet these recommendations in the short and long term, including government commitment to quality health service delivery in the context of universal health coverage, while recognizing the time required to action such changes.

Feasibility

The GDG believes that this recommendation is feasible in most circumstances. However, in extreme cases, adherence to this recommendation may not be possible and facilities should find interim solutions in order to provide the safest care possible. Moreover, implementing a national plan for human resource development will be highly beneficial for the successful implementation of this core component.

Acceptability

The GDG is confident that key stakeholders are likely to find the recommendation acceptable.

Conclusions

Following careful evaluation of the evidence, the panel recommended that all facilities should (1) not exceed standard bed occupancy capacity, and (2) ensure that health care worker staffing levels are appropriate to patient workload in order to reduce the risk of HAI and the spread of AMR.

Research gaps

Considering the evidence reviewed, the GDG noted that additional research is needed on the impact of patient-to-bed ratio on HAI and AMR spread, including cost-effectiveness, with an emphasis on multiple bed occupancy in adult, paediatric and neonatal populations. The panel felt that this should be extended to include the examination of overcrowding in emergency departments with respect to the acute risk of disease transmission as a public health concern. The GDG identified also an overall lack of understanding on the role of visitors/relatives as patient care attendants and their impact on workload, workflow and HAI, as well as the spread of AMR, and further research is needed on this topic. Further investigation regarding health care worker workload during outbreaks should also be considered. Finally, the identification of nursing activity scores for workload would be useful, particularly in LMICs.

Core component 8: Built environment, materials and equipment for IPC at the facility level

■ 8a General principles

GOOD PRACTICE STATEMENT

Patient care activities should be undertaken in a clean and/or hygienic environment that facilitates practices related to the prevention and control of HAI, as well as AMR, including all elements around WASH infrastructure and services and the availability of appropriate IPC materials and equipment.

General remarks

- The GDG deemed it essential to describe the appropriate water and sanitation services, environment, and materials and equipment for IPC as a core component of effective IPC programmes at health care facilities. Therefore, a good practice statement has been formulated and provides the directions and key content elements for this core component.
- The GDG considered that ensuring an adequate hygienic environment is the responsibility of senior facility managers and local authorities. However, the central government and national IPC and WASH programmes also play an important role in developing standards and recommending their implementation regarding adequate WASH services in health care facilities, the hygienic environment and the availability of IPC materials and equipment at the point of care. In some cases, the centralized production and distribution of supplies is an effective approach (for example, the production of alcohol-based handrub and soap by a central national pharmacy).
- All health care facilities should provide at least the following:
 - › water from an improved source located on premises;
 - › sufficient water available at all times for drinking, handwashing food preparation, personal hygiene, medical activities, cleaning and laundry;
 - › access to hand hygiene facilities equipped with alcohol-based handrubs and (where appropriate) with water, soap and disposable or clean towels at the point of care and within 5 meters of sanitation facilities;
 - › improved sanitation facilities located on premises that are functional with at least one toilet designated for women/girls to manage menstrual hygiene needs, at least one separated for staff and at least one meeting the needs of people with limited physical disabilities;
 - › adequate supply of appropriate personal protective equipment and puncture-resistant sharps' containers, containers for separating other types of health care waste and other supplies necessary for cleaning;
 - › clean hygienic conditions including regular cleaning of examination rooms, waiting areas, surfaces and toilets;
 - › health care waste is segregated, treated and disposed of safely, including autoclaving, incineration or removal for off-site treatment;
 - › adequate ventilation to meet comfort requirements and reduce the risk of transmission of airborne pathogens;
 - › adequate drainage of storm and wash water to prevent vector breeding;
 - › safe management of sewage/faecal waste including the use of well- managed septic tanks and leach fields, disposal into functioning sewers or off-site removal.
 - › adequate power for sterilization, incineration and medical devices;
 - › well-lit areas where health care procedures are performed and in toilet facilities, including at night;
 - › sufficient energy for pumping water, sterilization and operating health care waste equipment (that is, incinerators)
- Other requirements linked to relevant environmental factors associated with the risk of infection, in particular for acute care facilities are:
 - › dedicated centralized decontamination area and/or sterile supply department for the decontamination and sterilization of medical devices and other items/equipment supplied with sufficient water and power;
 - › adequate number of single rooms* (preferably with private toilet facilities) and/or rooms suitable for patient cohorting** for the isolation of suspected /infected patients, including those with TB and multidrug-resistant organisms, to prevent transmission to other patients, staff and visitors;
 - › proper ventilation system in health care settings in general (330) and in the operating theatre including either;
 - › negative or positive air pressure conditions depending on the situation (331);

- › dedicated clean storage area for patient care items and equipment, including sterile material, and a separate area for the storage of clean linen as outlined in the PAHO/WHO manual on *Decontamination and reprocessing of medical devices for health-care facilities* (2016) (332);
- › adequate facilities for safe disposal of health care waste including safe use and disposal of sharps;
- › risk assessment system and measures for patient and their families and staff protection during building and renovation work (333), especially in high-risk areas such as: Units where severely immunocompromised patients (transplant, patients with profound neutropenia etc.) are managed Intensive care, neonatal and burn units;
- › operating rooms
- The GDG emphasized the need for infection preventionists to be involved in planning all these activities and systems and in the design of buildings and infrastructures in health care facilities.

* Negative pressure ventilation conditions may be necessary to prevent transmission, for example, infections with multidrug-resistant/extensively drug-resistant strains of *M. tuberculosis*.

** If the number of isolation rooms is insufficient, patients with the same infection/multidrug-resistant organism (for example, respiratory syncytial virus, influenza virus, MRSA) may share the same bay, based on risk assessment evaluation by the IPC team.

Background

Safe, effective performance in the delivery of day-to-day patient care and treatment is crucial for optimal outcomes both for patients and health care workers' health and safety. In an effort to promote effective and standardized clinical practice in accordance with accepted guidelines, emphasis should be placed on optimizing the health care environment to ensure a work system that supports the effective implementation of IPC practices. Ensuring the provision of adequate water and sanitation services of appropriate materials, items and equipment and their exact placement or position are recognised as critical elements of human factors engineering (ergonomics), which support their appropriate use and increases compliance with good practices. Ultimately, this contributes to effective implementation and the attainment of the desired behaviour supporting IPC.

Several environmental issues are of concern for IPC. The most relevant are those that deal with some features of the building design and WASH-related conditions in the health care facility.

We outline here the most relevant elements for a safe environment supporting appropriate IPC practices according to expert consensus. Based on the available evidence, section 8b includes a specific recommendation proposed by the GDG on hand hygiene facilities.

Health facility infrastructure and WASH

An appropriate infrastructure including the health care facility building and the availability of safe water and sanitation facilities according to international and national standards (32) are essential requirements. In the absence of such facilities, IPC cannot be effectively implemented and health care worker, patient and visitor safety are put at great risk. IPC teams should be involved in the design, construction

and commissioning of any new or upgraded building from the early stages. Equally important is the engagement of the IPC team when major renovation or demolition work is being planned as these situations can represent a risk to patient safety through the heavy release of fungi into the air.

The following points highlight the IPC requirements **for water supply and sanitation** in a well-designed, safe health facility:

- **Adequate and continuous supply (quantity, quality and access) of safe water:**
 - › 5-400 litres per person per day (outpatient services require less water, while operating and delivery rooms require more water) (32).
 - › Safe water should be available in all treatment wards and in waiting areas.
 - › Water should be available for drinking in compliance with WHO *Guidelines for drinking water* (334), hand washing for food preparation, personal hygiene, medical activities, cleaning and laundry. This includes water for bathing, which is necessary before surgery and for general hygiene and the dignity/respect of patients.
- Water-associated infectious risks, such as legionellosis, should be appropriately managed.
- **Adequate sanitary facilities** should be in place in all health care facilities (32):
 - › At least one toilet for every 20 users for an inpatient setting.
 - › Toilets should be built according to technical specifications to ensure that excreta are safely managed.
 - › Sanitation quality should be appropriate, safe, clean and accessible to all users, including those with reduced mobility A reliable water point with soap should be available in all treatment areas and waiting rooms, and close to toilets for patients and staff to wash their hands.

- › Faecal waste should be safely managed either through on-site facilities or off-site through disposal into a functioning sewer or other safe removal and eventual treatment means.
- **Sufficient energy** should be available to pump water, power health care waste destruction technologies and provide lighting for toilets.
- Available, good quality, close to the point of use and readily accessible.
- Stored in a clean/dry area to prevent contamination until required for use.
- Preferably single use. For reusable items/equipment, there must be a clear policy and standard operating procedure for placement and decontamination.

Key building features for appropriate IPC

- Adequate ventilation should be in place for isolation rooms.
- Adequate facilities required for the isolation of patients requiring contact and airborne precautions (see below for further details).
- The facility should be built in a way so that traffic flow can be regulated to minimize exposure of high-risk patients and to facilitate patient transport.
- Precautions to control rodents, insects and other vectors of disease should be in place, including use of screens and bed nets to protect against mosquitoes.
- Appropriate facilities (for example, sluice area, bedpans, urinals, etc.) in place for waste management (see below for further details).

In particular, it is essential that the floor space be adequate between beds for activities to take place and to avoid cross-contamination between adjacent bed spaces (32). The exact floor/bed space is influenced by the type of health care facility, staff activity and type of patient. Ergonomic studies have established that most activities carried out at the bedside can be accommodated within the dimensions 3600 mm (width) × 3700 mm (depth). This represents the clear bed space and does not include space for fixed storage, preparation and worktops (335). The bed space (2.5 metres between beds) for critical care areas needs to be greater for reasons of circulation space and the equipment used in these areas.

WHO considers the standard for bed occupancy to be one patient per bed and that this should not be exceeded. This is in direct support of the WHO standard on facility design, recommending one patient per bed with adequate spacing (1 metre between beds) between patients. As a part of good practice and to prevent cross-infection, WHO recommends that bed-sharing be avoided.

Personal protective equipment

Medical non-sterile and surgical sterile gloves, surgical masks, goggles or face shields and gowns are considered as essential personal protective equipment. Respirators and aprons should also be available in adequate quantities in all facilities for use when necessary. All personal protective equipment should be:

A standardized operating procedure and management system should be in place for stock ordering and rotation to ensure that there is always an adequate supply based on usage and that older items are always used first.

Decontamination of items, equipment and medical devices

Sterilization or decontamination of items, equipment and medical devices is a complex and highly specialized subject. All patient care surfaces, medical devices and equipment used in health care have the potential to become contaminated with microorganisms. Once contaminated, these items can pose a risk to patients, staff and visitors. As an essential component of IPC strategies, all health care facilities should implement a standardized operating procedure for the safe and effective decontamination of high-touch patient care areas and all reusable items/equipment to prevent cross-infection. It is essential that facilities have a dedicated area for the decontamination of reusable items/equipment. Depending on their complexity and activities, health care facilities should also provide high-quality and efficient sterilization of clinical materials that are considered critical according to the Spaulding classification (336). This includes sufficient and reliable energy to power sterilization devices. Staff working in decontamination units and the sterile services department must receive adequate training (with regular updates). The building design of the decontamination unit and sterile services department must meet international standards (332).

Isolation capacity

Isolation involves the creation of a barrier to prevent the spread of infectious diseases and multidrug-resistant organisms from one patient to another and to health care workers, carers and visitors. To achieve effective isolation, designated single rooms (preferably with private toilet and shower facilities) should be available to place suspected or confirmed infectious patients. Therefore, the structure of the environment must support effective isolation according to the following principles:

- Patients should be informed about their infection in a clear and understandable way and reminded how to prevent spread to others.
- Items used by patients during isolation should *not* be shared between patients.

- Personal protective equipment should be changed following direct contact with patients, even if being cared for in the same isolation area with the same communicable disease.
- Hand hygiene should be performed at all times when needed according to the WHO recommendations and the “5 moments for hand hygiene” approach.
- Patient transport and movement to other wards/department should be restricted or limited, unless medically necessary.

For children in isolation, only plastic toys can be allowed so that they can be cleaned and disinfected after use before being shared with any other children.

Visitors should be restricted and information should be provided on the danger of infection. Requirements for hand hygiene should be emphasized and appropriate personal protective equipment should be provided based on the mode of transmission of infections.

Waste management structures and processes

Adherence to established environmental standards should be observed in all waste management activities and compliance with national/international policies on waste, environmental health and vector control. Health care waste management is a process that includes all activities involving waste generation, waste minimization, avoidance, segregation, collection, transportation, storage, treatment and final disposal or recycling and reuse for all waste types generated (337). Appropriate segregation of waste at the point of generation, including sharps, and the collection and adequate disposal of waste are essential to prevent the spread of infection to patients, staff and visitors. Guidelines and local standardized operating procedure on regular collection and disposal are essential to keep the environment clean and safe and reduce odours and attraction for animals. Improper disposal of infectious health care facility waste may also pose a risk of infection to the community at large.

Procurement and use of single-use devices and safety-engineered injection devices

Procurement and distribution of sufficient quantities of good quality single-use devices is a necessary prerequisite to avoid unsafe practices of reuse of medical devices. Therefore, a supply management system based on needs should support continuous procurement of single use devices.

Regarding injection devices, all health care facilities should follow WHO guidelines and principles for safe injections and safe sharps’ management. Furthermore, all facilities should procure and use syringes with reuse protection mechanisms

and with “sharps’ injury protection” (that is, features to protect health care workers from needle-stick injuries). These devices should meet WHO quality standards and be used according to the WHO injection safety global policy (338).

Cleaning of the environment

A clean environment plays an important role in the prevention of HAI and spread of AMR. Many factors, including the design and organization of the health care facility, availability and access to safe water, appropriate sanitation, laundry systems and air quality can significantly influence the transmission of infection. The environment must be thoroughly cleaned by applying the following general principles:

- Cleaning consists of the removal of dust, soil, and contaminants on environmental surfaces and ensures a dry, hygienic and healthy health care facility environment for patients, staff, and visitors.
- Cleaning is an essential step prior to any disinfection process as it removes dirt, debris and other materials, which decrease the effectiveness of chemical disinfectants.
- The use of neutral detergent solutions is essential for effective cleaning.
- Special attention should be given to sanitation or toilet facilities as these are often areas that are heavily contaminated and reservoirs for HAIs.
- Routine bacteriological monitoring to assess the effectiveness of environmental cleaning is not required.

Large-surface cleaning methods should be avoided because they produce mists or aerosols or disperse dust in patient-care areas (for example, dry sweeping, spraying or dusting). Airborne fungal spores are especially dangerous as they can cause fatal infections in immunosuppressed patients.

Core component 8: Built environment, materials and equipment for IPC at the facility level

■ 8b Materials, equipment and ergonomics for appropriate hand hygiene

RECOMMENDATION

The panel recommends that materials and equipment to perform appropriate hand hygiene should be readily available at the point of care*.

(Strong recommendation, very low quality of evidence)

Rationale for the recommendation

- Evaluation of the evidence from 11 studies shows that the ready availability of equipment and products at the point of care leads to an increase of compliance with good practices and the reduction of HAI. In 6 of the 11 studies, the intervention consisted of the ready availability and optimal placement of hand hygiene materials and equipment in areas designated for patient care or where other health care procedures are performed and led to a significant increase of hand hygiene compliance. No meta-analysis was performed due to the different methodologies and varied outcome measures. Therefore, the GDG decided to focus on hand hygiene in particular and to recommend that materials and equipment to perform hand hygiene should be readily available at all points of care. The overall quality of the evidence was very low, but the GDG unanimously decided that the strength of this recommendation should be strong considering that the content refers to other key WHO *Guidelines on hand hygiene in health care* already implemented worldwide.

Remarks

- Although the evidence was largely limited to hand hygiene materials and equipment, there is consensus that other IPC supplies and tools support health care workers in performing the desired clinical behaviour, as mentioned in the good practice statement section of this chapter.
- The GDG remarked that the WHO standards for the adequate number and appropriate position of hand hygiene facilities should be implemented in all health care facilities as follows:
- Water, soap, and single-use or clean reusable towels and alcohol-based handrub dispensers should be available in all key areas of the facility (point-of-care and at least in all toilet facilities) to ensure good practices and compliance with the WHO '5 moments' for hand hygiene. Regarding hand washing stations, WHO recommends a minimum of one hand wash basin per every 10 beds and alcohol-based handrubs readily available at each point of care (35).

* The place where 3 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). The concept embraces the need to perform hand hygiene at recommended moments exactly where care delivery takes place. This requires that a hand hygiene product (for example, alcohol-based handrub, if available) be easily accessible and as close as possible – within arm's reach of where patient care or treatment is taking place. Point-of-care products should be accessible without having to leave the patient zone. The WHO *Guidelines on hand hygiene in health care* state: "minimum sink-to-bed ratio 1:10 and 1:1 in isolation rooms" (35)

Background

Hand hygiene is considered as the cornerstone of clinical practice that is essential for the prevention of HAI and spread of AMR. WHO issued global guidelines including evidence- and consensus-based recommendations on hand hygiene in health care, together with an implementation strategy and toolkit (<http://www.who.int/gpsc/5may/tools/en/>). These are considered to be the gold standard and are implemented in many countries worldwide. A multimodal strategy is the internationally accepted approach to achieve hand hygiene behavioural change (core component 5). One of the five core elements of the WHO hand hygiene improvement strategy relates to the work system within which hand hygiene takes

place, that is, an environment including infrastructure and materials that facilitate compliance at the point of care.

Summary of the evidence

The purpose of the evidence review (web Appendix I) was to evaluate the effectiveness of IPC programmes. One component identified was the availability of materials and equipment to perform IPC good practices at the point of care. The primary outcome was the impact on HAI and hand hygiene compliance.

Eleven studies were included, 10 from the SIGHT review and one from its update. For hand hygiene, a total of six studies

comprising one RCT (339), four non-controlled before-after (132, 340-342) and one qualitative study (148) were identified. A determinant of hand hygiene compliance was the placement of handrub dispensers at the point of care within the context of a multimodal improvement approach (132, 339, 341, 342). One additional study supplied 'pocket bottles' of alcohol-based handrub to anaesthesiologists and showed a marked increase in their hand hygiene behaviour (340). In one qualitative study, it was noted that a source of frustration for health care workers is when there is limited access to hand hygiene facilities (148).

In addition, three studies showed that customized insertion kits for central venous catheters, as well as pre-stocked carts, helped to decrease the rates of central line-associated bloodstream infections (45, 48, 129). In one study, improved prescribing of isolation measures was associated with the use of electronic reminders for doctors when ordering isolation precautions for patients fulfilling the criteria (343).

All studies were performed in high-income countries only. The studies included in the SIGHT review (2) were rated as moderate quality evidence according to ICROMS. However, all but one did not meet the recommended study design types as outlined by the EPOC criteria (9). For this reason, the GDG decided that the overall quality of the evidence is very low.

Additional factors considered when formulating the recommendation

Values and preferences

No study was identified on patient values and preferences. However, the GDG is confident that patients in all settings would place a high value on appropriate infrastructures and readily available materials and equipment at the point of care to enhance appropriate hand hygiene and other IPC practices. Furthermore, policy-makers, health care providers and the health workforce are likely to place a high value on having access to the correct materials and equipment that facilitates hand hygiene within the context of safe service delivery.

Resource implications

The GDG is confident that the resources required are worth the expected net benefit and that implementing this recommendation is likely to reduce overall health care costs. The expert panel did remark that not all solutions require additional resources and can be low cost, such as the optimal placement of hand hygiene materials that support the workflow of health care workers and their behaviour. To

help reduce resource implications, further development of the local production of hand hygiene products should be a priority for implementation of this recommendation in LMICs.

Feasibility

The GDG is confident that this recommendation is feasible and can include low-cost solutions.

Acceptability

The GDG is confident that key stakeholders are likely to find this recommendation acceptable as hand hygiene is a fundamental clinical practice for all health care workers.

Conclusions

Based on the available evidence that was mostly focused on hand hygiene, the GDG concluded that ensuring available and appropriate hand hygiene materials and equipment at the point of care with optimal placement will assist in the performance of appropriate hand hygiene practices.

Research gaps

The GDG identified the need for more research of good quality to evaluate the impact of system change on HAI and AMR reduction, in addition to change of practices. Furthermore, the implementation of local alcohol-based handrub production should be further investigated, including quality control and acceptance aspects.

9 Planned dissemination and implementation of the guidelines

The overall aim of these guidelines is to improve the quality and safety of health care and the outcome of patients accessing health services, as well as the safety of health care workers. Uptake of the guidelines by all players across all levels of the health system is therefore essential.

Adoption of the recommendations and adaptation of existing approaches to IPC at the national and facility level are key elements to success. The inclusion of the core components for IPC programmes in the national action plans for AMR is crucial for the achievement of strategic objective 3 of the AMR Global Action Plan adopted by all Member States at the World Health Assembly in 2015 and expected to be implemented by 2017. Their translation into strategy and practice is the ultimate and most important goal to achieve a reduction of harm due to HAI and the spread of AMR. The dissemination and implementation of these guidelines are crucial steps that should be undertaken across the international community, as well as at the national and local level. Success will be influenced by the extent to which these guidelines are perceived as relevant by leads responsible for IPC and work is required to explore how best to facilitate effective interlinkages of IPC with national bodies responsible for health security, public health (including essential public health functions), supply chain and logistics, finance and other influential actors on whom successful implementation is dependent.

It is important to note that the core components of national and facility level programmes are interrelated in practice. It is key that national IPC programmes support the local programmes by several means, including setting national standards, fostering the training and recruitment of infection preventionist staff, facilitating regular provision of IPC supplies and an adequate environment, and the development of coordination activities with the local IPC and other IPC-related programmes. The separation into discrete sections

is for the purpose of the evidence review. Implementation requires consideration of the components as part of an interrelated package addressing the different factors that need to be considered in the development of an effective IPC programme.

Guideline implementation

The successful implementation of the recommendations and good practice statements in these guidelines is dependent on a robust implementation strategy and a defined and appropriate process of adaptation and integration into relevant regional, national and facility level strategies. Implementation effectiveness will be influenced by existing health systems in each country, including available resources and the existing capacity and policies. The support of key stakeholders, partner agencies and organizations is also critical.

The IPC Global Unit of the WHO SDS Department is working with international experts, stakeholders and field implementers on the development of a separate resource to accompany the guidelines, which will be dedicated to strategies for their implementation at the national and facility level. In particular, guidance will be developed on how to prioritize and implement the IPC core components in settings with limited resources. Furthermore, a comprehensive range of new IPC training packages will be produced in line with the core components' principles and IPC best practices. This work is informed by the growing body of evidence in the field of implementation and behavioural change science and successful strategies and protocols for the implementation of IPC measures, including those recommended by these guidelines.

Guideline dissemination

The guidelines, along with all supplementary and additional information, will be made available online and in print and will also be accessible through the WHO library database, the WHO IPC Global Unit web pages, the WHO Department of Service Delivery and Safety web pages and the Integrated,

People-Centred Health Services platform.

Active dissemination will then take place through a number of mechanisms including (though not limited to):

- The Global IPC Network and the WHO Save Lives: Clean Your Hands and Safe Surgery Saves Lives global campaigns
- WHO collaborating centres
- WHO stakeholders and collaborators (for example, other Service and Delivery Units, WASH, AMR)
- WHO regional and country offices, ministries of health, nongovernmental organizations (including civil society bodies)
- Other United Nations agencies
- Professional associations.

Consideration will be given to the role of regional dissemination workshops and other international conferences and meetings, depending on successful resource mobilization.

The use of social media within the context of mobile health technologies will also be explored as a mechanism to supplement conventional dissemination approaches.

An in-print version of the complete guidelines will be made available in all official United Nations languages. Third-party translations into additional non-United Nations languages will be encouraged, complying with WHO guidance on translations. A short summary of the guidelines will be made available in print and online.

Technical support for the adaptation and implementation of the guidelines in countries will be provided at the request of ministries of health or WHO regional or country offices.

The IPC teams at all 3 levels of WHO will continue to work with all stakeholders and implementers to identify and assess the priorities, barriers and facilitators to guideline implementation. The team will support the efforts of stakeholders to develop guideline adaptation and implementation strategies tailored to the local context. Adaptation of the recommendations contained in the guideline is an important prerequisite to successful uptake and adoption to ensure the development of locally appropriate documents that are able to meet the specific needs of each country and its health service. However, modifications to the recommendations should be justified in an explicit and transparent manner.

Plans are being developed to conduct pilot implementation in some countries, particularly in the African Region and the Region of the Americas. All these activities will be supported by specific communication messages and, importantly, by the development of implementation strategy documents and tools that will be issued shortly after publication of the guidelines.

Dissemination through the scientific literature is considered crucial for the successful uptake and adoption of the recommendations and WHO and members of the Systematic Reviews Expert Group aim to develop a number of papers for publication in peer-reviewed journals.

Review, update and evaluation of the recommendations

Implementation of these guidelines can be measured in a number of ways and an evaluation framework will be developed by the WHO IPC Global Unit in collaboration with stakeholders involved in the guideline development. Lessons learned from the dissemination and implementation of the original WHO *Core components* document (2009) will be reviewed in the development of the evaluation strategy. Mechanisms will be explored to track:

- The number of countries that incorporate the IPC core components in their national IPC programmes. At present, no monitoring system exists that can collect this information in a comprehensive manner on a routine basis. However, the WHO Global Analysis Assessment of Sanitation and Drinking-Water survey (http://www.who.int/water_sanitation_health/glaas/en/) is regularly repeated and collects data on WASH in health care facilities and the use of other online IPC surveys will be explored with regional IPC focal points.
- The number of print copies and downloads from the WHO website as an indicator of interest in the guideline.
- The number of requests for technical assistance from Member States.
- Requests relating to adaptation and translations.
- Informed by the evaluation approach, WHO will establish a review period for these guidelines every 3-5 years.

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ANNEX V

A Holmes declaration of interests

Value	Project name	Principal investigator	Funder	Start	End
£101 611	Networks for Excellence – Engineering solutions to AMR	Holmes	Wellcome Trust via ISSF	01/10/2015	28/02/2017
£687 740	NIHR i4i “EPIC IMPOC” – ‘Enhanced point of care infection management policy application in critical care and therapeutics’	Holmes	NIHR	05/08/2015	04/08/2018
£749 583	Engineering, Physical, Natural Sciences and Medicine Bridging Research in Antimicrobial resistance: Collaboration and Exchange (EMBRACE).	Toumazou/ Holmes/ Armstrong	EPSRC	01/08/2015	31/07/2017
£50 000	Collaborative in AMR: Life Science and Engineering, Scoping, Community-building and Engaging (COALESCE)	Holmes/ Toumazou/ Armstrong/ Young/ Donaldson	EPSRC Institutional sponsorship	01/06/2015	31/03/2016
£137 625	Investigating stratified antimicrobials use for improved management of infections and to minimise AMR: Through the integration and application of enhanced use of existing NHS data, advances in diagnostics technology, bacterial genetics and clinical pharmacology	Holmes	BRC	01/04/2015	31/03/2017
£30 000	Reducing neonatal mortality and paediatric infection through improved patient safety in Rwanda	Holmes	Tropical Health Education Trust	01/03/2013	30/06/2015
£165 941	Eleanor Murray Health Foundation Share Purpose	Holmes	Health Foundation	01/01/2013	31/12/2015
£117 843	Health foundation spotlight on health care-associated infection	Holmes	Health Foundation	01/01/2013	15/03/2014
£456 042	Patient Safety Translational Research Centre	Holmes	ICHNT / NIHR	01/08/2012	31/07/2017
£20 000	Enhances prescribing through CBR-based Imperial Antibiotic Prescribing Policy smartphone application (ENIAPP)	Holmes / Georgiou	Imperial College	01/04/2013	31/03/2013
£7155	Systematic review and meta-analysis of interventions to improve antibiotic prescribing practices for hospital inpatients	Holmes	CSO research grant	01/03/2013	28/02/2015

AMR: antimicrobial resistance; NIHR: National Institute for Health Research; ISSF: Institutional Strategic Support Fund; EPSRC: Engineering and Physical Sciences Research Council; NHS: National Health Service; BRC: Biochemical Research Centre; ICHNT: Imperial College Healthcare NHS Trust; CBR: case-based reasoning; CSO: Chief Scientist Office.



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