

## EXECUTIVE SUMMARY

Healthcare-associated infections (HAIs) are the most frequent adverse events in healthcare delivery. They are associated with morbidity and mortality, longer hospital stay, and increase costs. The four major types are catheter-related bloodstream infection (CRBSI), surgical site infection (SSI), ventilator-associated pneumonia (VAP), and catheter-related urinary tract infection (CAUTI). They share one characteristic: they are preventable. A growing body of evidence suggests that so-called “best practice” procedures reduce HAI. In parallel, there has been a proliferation of clinical practice guidelines in the field of infection prevention and control (IPC). However, the scope and quality of such documents remain unknown, including how consistently they are actually used in clinical practice. Given the increasing evidence base, it is often assumed that hospitals adopt practices and procedures with proven effectiveness, but no effort to explore the implementation of IPC practices has been undertaken on a large scale and across different sociocultural backgrounds. In addition, it is not known whether it is possible to implement a multimodal infection prevention strategy in culturally diverse countries, such as in Europe. CRBSI is a prototype of causality and prevention of HAI and represents an ideal scenario to study the effectiveness of such a programme on a European level. Emphasis should be given to the role of hand hygiene in this context since hand hygiene has been widely promoted in Europe (and throughout the world) over the past two decades.

The aim of the *Prevention of hospital infection by intervention and training* (PROHIBIT) project was to provide a global perspective of IPC activities in Europe on several levels, i.e. availability of published guidelines and recommendations, management and organisation of infection control, the capacity of hospitals to implement a multimodal intervention programme, and identification of barriers and facilitators in implementing IPC programmes in European hospitals. Four scientific work packages addressed these topics using a mixed-methods approach combining a systematic review, a large-scale survey, state-of-the art qualitative research, and a randomised controlled trial.

Guidelines serve as a reference for good practice. The challenge in Europe is language and the many different healthcare systems. Variation in scope, update, and quality of the many documents analysed in PROHIBIT was not unexpected. Some websites were not particularly user-friendly and the documents proved difficult to retrieve, which we assume works against accessibility and the wide dissemination of recommendations. To provide the same level of evidence for all patients in Europe, it is necessary to ensure that the offered documents are of good quality, regularly updated, and an accurate reflection of scientific evidence. It is no longer acceptable that healthcare professionals have to rely on outdated or incomplete documents solely because English is not their first language. Access to updated state-of-the-art guidelines in their own language is the *sine qua non* of improvement in quality of care.

Twenty-four countries provided data from more than 300 acute care hospitals related to the organisation of IPC and the implementation of evidence-based best practice procedures. Hospitals employed a median of four IPC nurses and one doctor per 1000 beds. When compared to previous surveys, the staffing level has not changed over the past years and remains at the level of the seminal United States (US) study on the efficacy of nosocomial infection control (SENIC) conducted 30 years ago. However, current expert opinion suggests that the SENIC staffing key is outdated and the per-bed rate of IPC professionals should be approximately one per 100 beds in acute care and one per 150-250 beds in long-term care. Two-thirds of the hospitals have introduced a link-nurse system. The vast majority (91%) have established an interdisciplinary IPC committee to define infection control objectives, predominantly addressing hand hygiene compliance, reduction of one or more HAIs and, to a lesser extent, antibiotic stewardship. Most hospitals offer training for hand hygiene. Education addressing other IPC topics are organised less often. Not unexpectedly, we observed a substantial variation of specific IPC procedures. For example, pre-surgical shaving is still common for hair removal and skin antisepsis for surgical procedures is still performed using aqueous iodine or alcohol

alone in some hospitals. This raises concerns about the way in which hospitals decide to adopt practices. Procedures for the prevention of other HAIs, such as catheter-related infection, show less variation. The reported consumption of alcohol-based handrub (AHBR) is low: 21 ml per patient-day, thus confirming the findings of the most recent European point prevalence survey (19 ml per patient-day). Assuming that 2-3 ml are necessary for a single handrub action, the use of AHBR in Europe is largely insufficient. Despite the many initiatives in past years, more must be done to improve hand hygiene. Interestingly, countries that spend more than the European average of 6.5% of the gross domestic product (GDP) for healthcare consumed significantly more handrub per patient-day than those spending less than the European average.

The randomised controlled trial to reduce CRBSI by promoting hand hygiene and/or a multimodal CVC bundle intervention was a success. Fourteen centres in 11 European countries (Austria, Belgium, Greece, Hungary, Ireland, Italy, Latvia, Poland, Romania, Slovenia, and Spain) participated in this intensive care unit (ICU)-centred study. An already relatively low infection rate of 2.4 CRBSI per 1000 catheter-days was further reduced to 0.9 infections per 1000 catheter-days. Compliance with hand hygiene recommendations and best practice at catheter insertion improved almost everywhere. Hospitals in Latvia, Hungary, and Ireland were among those with high baseline infection rates. This raises concerns about the role of public healthcare expenditure in quality of care as these three countries spend the lowest portion of health expenditure for public health according to the World Bank. The average baseline hand hygiene compliance of 49% was similar to the recent *Mastering hospital antimicrobial resistance* (MOSAR) study, which was done in similar clinical settings. The hand hygiene programme, based on the strategy of the World Health Organization (WHO), alone or in combination with the catheter bundle, significantly improved hand hygiene compliance. The greatest effect was achieved in the group of hospitals that were randomised to apply the hand hygiene programme only. However, improved hand hygiene improvement was observed also in some of the hospitals that were allocated to implement only the catheter bundle. Similarly, compliance with our catheter insertion checklist improved in hospitals that were randomised to implement the catheter bundle intervention, either alone or in combination with a hand hygiene promotion strategy. The catheter bundle and the insertion checklist were based on a successful prevention programme conducted at the University of Geneva Hospitals (Geneva, Switzerland). Some hospitals in the group randomised to promote only the hand hygiene strategy also improved compliance with the checklist, but the effect was low.

Multimodal intervention strategies or even a simple hand hygiene intervention are not hard-edged programmes. Hospitals are likely to adopt procedures other than the ones prescribed by a programme such as PROHIBIT, e.g. they improve hand hygiene when the intervention is the implementation of a catheter bundle, or they improve catheter insertion and care when the intervention is a hand hygiene promotion programme. We were aware that this would happen when the intervention was designed. For ethical reasons, we did not prevent hospitals from improving procedures other than the ones they were randomised to and we deliberately left room for local adaptation of the intervention by centrally training local stakeholders. Although we cannot distinguish formally the effectiveness between the hand hygiene programme and the more comprehensive catheter bundle implementation, we learnt much about the dynamics of implementing a multimodal strategy. The programmes always focused on a core intervention, i.e. the WHO hand hygiene strategy or the Geneva central-line infection prevention programme, but the boundaries of the interventions were not sharply defined. Encouraged by participating in a European study, local stakeholders developed a range of activities around the core intervention that met the local organisational culture aspects and finally guaranteed success. The study confirmed that multimodal infection prevention interventions are feasible and effective in culturally-different European countries if room is left for local adaptation.

Six themes emerged as the most relevant facilitators and barriers to implementation of the PROHIBIT hand hygiene and catheter bundle programme. However, we observed a considerable variety in the implementation narratives and pivotal drivers of the implementation process. Combinations of factors led to implementation success rather than any one single facilitator. People

always made a difference with their talent being important, as well as their position in the institution, and if they succeeded in being boundary spanners between the different professional groups. Surprisingly and noteworthy, success occurred in organisational and cultural environments that appeared to be the most challenging prior to the intervention. The context of an international, evidence-based initiative, but still leaving room for local adaptation, was a major driving and enacting force. Providing hospitals with 50% of a nurse's salary helped to generate the necessary focus and, together with social bonding among change agents, generated a commitment to succeed. While the halo effect of PROHIBIT was instrumental in under-resourced settings, the provided resources were integrated into pre-existing, locally-branded programmes in institutions that viewed themselves as leaders in the field. Prior to PROHIBIT, all institutions demonstrated knowledge on international good practice guidelines and even local protocols for CRBSI prevention, but not all hospitals had established best practice procedures in their ICUs. We believe that a theoretical framework of social norm activation within and across institutional boundaries, rather than diffusion of innovation, applied as a model in most cases. Establishing a link between the qualitative analysis and the quantitative results remained challenging due to the small number of cases, the already low baseline rate in some hospitals, and the relatively short follow-up time. An important message comes from the fact that the highest baseline rate reduction was most prominent in the most challenging pre-implementation contexts. Unsurprisingly, implementation relied heavily on the commitment of engaged leaders who succeeded to reduce CRBSI even in hostile environments. Of note, if such commitment is not supported by good IPC structures, it may not be sustainable.

## Recommendations to the European Commission

The overarching objective of PROHIBIT was to provide the vision for policy-makers, managers, and healthcare workers (HCWs) to prevent HAI by improving the understanding of European guidelines and hospital policies and practices, by overcoming common obstacles for implementing evidence-based best practices, and by testing the effectiveness of two interventions to prevent CRBSI. As a consequence and based on the findings of PROHIBIT, we suggest a number of actions to the European Commission (EC) as to how IPC can be made more relevant in Europe, as well as tangible recommendations to improve patient safety.

- *Establish a European IPC strategy.*
- *Establish a European-wide surveillance for outcome and/or process indicators (a prospective initiative or repeated point prevalence surveys as done at present).*
- *Create and sustain an IPC platform that serves as a European IPC network.*
- *Consider train-the-trainer workshops for hospital staff on a European level.*
- *Consider providing dedicated salaries for a limited time period to get IPC programmes off the ground*
- *Establish an authoritative body for state-of-the-art guideline production.*
- *Encourage the adoption of evidence-based IPC strategies in European hospitals through authoritative guidelines and prevention projects.*
- *Improve hand hygiene in hospitals through a European initiative.*
- *Raise awareness of the importance of IPC among European HCWs, particularly doctors.*
- *Foster a positive organisational culture and teamwork in European hospitals.*
- *Encourage (or mandate) hospitals to establish IPC standards of staffing and organisation/structure (IPC goals, indicators, committee).*
- *Encourage the establishment of link nurses and doctors (or liaisons) at the hospital level to span institutional boundaries and facilitate multidisciplinary collaboration.*
- *Encourage countries to provide a budget for IPC activities; in particular, ensure that IPC budgets in hospitals are separate.*
- *Fund high-quality effectiveness research in the field of IPC emphasizing implementation and behaviour change*