Improving Patient Safety in Europe

Technical Implementation Report

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Volume I

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2.	-	Meetings and Training Events http://ipse.univ-lyon1.fr/Working packages/WP8&9/Events.pdf
3.	-	Codes http://ipse.univ-lyon1.fr/Working packages/WP8&9/Codes.pdf
4.	-	European Survey – Competencies and Training of Infection Control Practitioners in Europe http://ipse.univ-lyon1.fr/Documents/WP1_Survey_Results.pdf
5.	D1.1	Register of European Courses in Infection Control http://ipse.univ-lyon1.fr/Working packages/WP1/Euro_Courses_Register.pdf
6.	D1.2	Core Curriculum for European Training http://ipse.univ-lyon1.fr/Working packages/WP1/Core Curriculum.pdf
7.	-	European Survey – National Recommendations & Indicators on HAI & AMR http://ipse.univ-lyon1.fr/Documents/WP2 Survey Results.pdf
8.	-	Local Checklist – Raising Standards of Infection Control in Europe http://ipse.univ-lyon1.fr/Documents/Local Checklist.pdf
9.	D2.1	Guidance on Infection Control in Healthcare Settings in Europe: Standards, Indicators and Recommended Practices for monitoring the control of HAI & AR http://ipse.univ-lyon1.fr/Infection Control Guidance.pdf
10.	D2.2	Summary – Local Checklist – Raising Standards of Infection Control in Europe http://ipse.univ-lyon1.fr/Working packages/WP2/Local Tool Summary.pdf
11.	-	HELICS SSI Surveillance Statistical Report 2004 - 2006
12.	-	HELICS ICU Surveillance Statistical Report 2004 - 2006
13.	D7.1	European Survey – Infection Control in Nursing Homes and Home Care Organisation http://ipse.univ-lyon1.fr/Documents/IPSE WP7 Deliverable D7.1.pdf
14.	D7.2	Proposal for Surveillance of Nursing Home Acquired Infections in Europe http://ipse.univ-lyon1.fr/Documents/Nursing Homes Protocol.pdf

Forward

With the first Council of Europe recommendations in 1974, the need for harmonisation of nosocomial infection control policies in Europe started to be recognised. Health systems in European countries increasingly gave priority and resources for initiatives to foster nosocomial infection surveillance and control activities in order to improve the quality of patient care through valid outcome data.

From 1994, the European Commission supported the HELICS (Hospitals in Europe Link for Infection Control through Surveillance) group in creating the scientific conditions necessary for an harmonised approach of surveillance. The objective was the harmonisation of existing European networks and the solution of the technical problems of producing epidemiological data and other relevant information for these infections. This work was underpinned by the ideas that feedback of data on NI had been shown to be effective in reducing the incidence of nosocomial infections and should therefore be encouraged, and that good quality comparative data could be used to identify measures that prevent them. Two targets received a high level of consensus for implementation at the European level:

- infections in the intensive care unit (with three optional levels of comprehensiveness in data collection and analysis).
- infections in surgical patients.

Having achieved these high levels of consensus, the challenge then shifted towards the organisation of routine production and dissemination of analyses and extending the coverage of the programme progressively to countries or regions with little or no experience of surveillance. By the end of 2004, and the end of an existing phase of EU support of HELICS activities, the HELICS database was established with a first retrospective data collection of surgical site infection and intensive care unit surveillance.

In 2005, by formulating a new project, called 'Improving Patient Safety in Europe', the intention was to build on the considerable efforts already made in harmonising data on nosocomial infections and antimicrobial resistance in Europe not only by strengthening and further developing existing surveillance initiatives, but also to undertake other approaches to support the wider infection control effort in Europe. The project aimed at resolving the persisting differences in preventive practices and outcomes across countries through the following aspects;

- Providing health services with information, guidance and tools to manage effectively the risk of nosocomial infections and antimicrobial resistance.
- Strengthening the status of professionals involved in infection control activities.
- Fostering the control of the emergence and spread of multiple resistant organisms in the intensive care unit through an integrated surveillance programme.
- Monitoring the level of achievement of nosocomial infection and antibiotic resistance control programmes.

To achieve these aims, an extended partnership was created, including the EU, WHO and ESCMID, some major public health institutes and EU supported networks. The results of the project are presented in this report and represent the very considerable efforts of the wide network of people whose collaboration and hard work the project depended on.

At the end of the project, responsibility for the activities was transferred to the European Centre for Disease Prevention and Control in Stockholm. The further development of the work undertaken by the project is already underway via their offices.

My sincere thanks are extended to the many scientists and members of surveillance networks who brought their considerable expertise, and also to the associated partners and institutions who made this collaboration successful, notably DG SANCO, ESCMID and WHO. Together, we marked out a pathway to more secure healthcare in Europe.

Jacques Fabry **IPSE Project Coordinator**

Project Identification

NAME Improving Patient Safety in Europe

COMMISSIONED BY

European Commission
Directorate General, Health and Consumer Protection

PROJECT COMMENCEMENT DATE

1st January, 2005

PROJECT COMPLETION DATE

30th June, 2008

MAIN PARTNER

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Lyon, France

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Swedish Institute for Infectious Disease Control
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Regional Health Agency
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The European Society of Clinical Microbiology and Infectious Diseases
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Institute of Hygiene
Vilnius, Lithuania

Institute of Public Health of the Republic Slovenia
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Ministry of Health of the Republic of Cyprus, Medical & Public Health Services
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Centre Hospitalier de Luxembourg
Luxembourg

Charité – Universitatsmedizin
Berlin, Germany

Vienna Medical University
Vienna, Austria

Velindre NHS Trust
Cardiff, United Kingdom

Acronyms

AB	Antibiotic
AMR	Antimicrobial Resistance
AR	Antibiotic Resistance
ARMed	Antibiotic Resiatance Surveillance & Control in the Mediterranean Region
ARPAC	Antibiotic Resistance Prevention and Control
ASR	Agenzia Sanitaria Regionale, Emilia-Romagna
Austria MUV	Medical University Vienna
Cyprus MHRS	Medical & Public Health Services, Ministry of Health, Nicosia
DG SRNs	DG SANCO Relevant Networks (EARSS, ESAC, HELICS and EWRS)
HAI	Hospital Acquired Infections/Healthcare Associated Infections
EAB	Expert Advisory Board
EARSS	European Antimicrobial Resistance Surveillance Scheme
ECDC	European Centre for Disease Prevention and Control
ECCMID	European Congress in Clinical Microbiology and Infectious Disease
ESAC	European Surveillance of Antibiotic Consumption
ESCMID	European Society of Clinical Microbiology and Infectious Disease
ESGAP	ESCMID Study Group on Antibiotic Policies
ESGARS	ESCMID Study Group on Antimicrobial Resistance Surveillance
ESGNI	ESCMID Study Group on Nosocomial Infection
ESGEM	ESCMID Study Group of Epidemiological Markers
ESICM	European Society of Intensive Care Medecine
EU	European Union
EWRS	Early Warning Reporting System
EZUS	EZUS SA (subsidiary of Claude Bernard University, Lyon)
FUH	Institute of Environmental Medecine & Hospital Epidemiology, Freiburg University Hospital
Germany NRZ	Charite – Universitatsmedezin Berlin (National Reference Centre for Surveillance (NRZ) on Nosocomial Infections)
HARMONY	Harmonisation of Antibiotic Resistance measurement, Methods of typing Organisms and ways of using these and other tools to increase the effectiveness of Nosocomial Infection control
HELICS	Hospital in Europe Link for Infection Control through Surveillance
HPA	Health Protection Agency, London
HVH	Vall d'Hebron University/Hospitals, Barcelona
ICU	Intensive Care Unit
IC	Infection Control
IFIC	International Federation of Infection Control
IPH/IPH-BXL	Scientific Institute of Public Health, Brussels
IPSE	Improving Patient Safety in Europe
IUMS	International Union of Microbiological Societies
Lithuania IH	Institute of Hygiene, Vilnius
Luxembourg CHL	Centre Hospitalier de Luxembourg
MS	Member States
MRSA	Methicillin resistant Staphylococcus aureus
NH	Nursing Homes
NI	Nosocomial Infections
PMG	Project Management Group
PH	Public Health
RIVM	The National Institute for Public Health and the Environment, Bilthoven
SARI	Surveillance der Antibiotika-Anwendung und der bakteriellen Resistenzen auf Intensivstationen
SHEA	Society of Healthcare Epidemiology of America
Slovakia PHI	Public Health Institute, Trencin

Acronyms (cont.)

Slovenia IPHRS	Institute of Public Health of the Republic Slovenia, Ljublana
Spain HVH	Hospital Universitari Vall Hebron, Barcelona
SMI	Swedish Institute for Infectious Disease Control
SSI	Surgical Site Infection
STRAMA	Swedish Strategic Programme for the Rational Use of Antimicrobial Agents and Surveillance of Resistance
UCBL	Claude Bernard University, Lyon
UK Wales NPHSW	Velindre NHS Trust (National Public Health Service for Wales), Cardiff
UEMS	Union Europeene des Medecins Specialistes (European Union of Medical Specialists)
WG	Working Group
WHO	World Health Organisation
WP	Work Package

1.0 Project Organisation

1.1 Project Coordination

The project was supported by an extended partnership, including the EU (DG SANCO), WHO, ESCMID, some major public health institutes and EU-supported networks. The overall coordination of the project was as follows;

DG SANCO funded the project via a grant in its 2004 Work Programme covering 60% of the project budget. The remaining 40% was provided by contributions from the project partners. The project start date was the 1st January, 2005. A request to extend the initial project duration of 3 years by a further 6 months was accepted, resulting in a completion date of 30th June, 2008. However, there was no change in the overall project budget resulting from this.

Coordination of the project was the responsibility of the main partner, Claude Bernard University Lyon1;

- **Technical Coordination** was carried out by the Programme Coordinator and Coordination Team based in the university's Laboratory of Epidemiology and Public Health.
- **Contract Coordination** was carried out by EZUS SA, a subsidiary of the university.

Associated Partners were those co-signatories to the contract receiving financial support for project activities and also contributing to the partner contribution element of the budget. The consortium consisted not only of some of national institutes concerned with nosocomial infection surveillance, but also organisations responsible for the running of sub-projects through Work Package leaders and collaborative teams based at various locations;

Work Package	Title	Work Package Leader
1	European Training for Infection Control Doctors and Nurses in connection with ESCMID	Claude Bernard University Lyon1
2	European Standards and Indicators for Public Health Surveillance and Technical Guidance for the Control of HAI and AMR	World Health Organization, Copenhagen
3	Event Warning and Rapid Exchange on NI & AMR	RIVM, Bilthoven
4	Technical Support for Sustaining and Extending HELICS Surveillance of Nosocomial Infections and control of HAI & AMR	Scientific Institute of Public Health, Brussels
5	Improving Surveillance and Controlling Antibiotic Resistance in ICUs	Swedish Institute for Infectious Disease Control, Stockholm
6	Providing Complementary Tools for the Study and Control of AMR in ICUs	Freiburg University Hospital
7	Feasibility Study of HAI Surveillance in European Nursing Homes	Regional Health Agency, Bologna
8	Dissemination	Claude Bernard University, Lyon
9	Project Management	Claude Bernard University, Lyon

National Contact Points were designated by the competent authorities in each country, in accordance with the terms of the grant agreement, to act as a focal point for the participation of each country concerned in the project.

The **Project Management Group** was comprised of work package leaders and experts from other participating partner institutions**.** The Programme Coordinator chaired the PMG, which assisted in decisions concerning project achievements and overall quality.

The **Expert Advisory Board** was comprised of individuals responsible and familiar with the practical and scientific challenges concerning the project, and provided an external view on the advancement of the project and proposed improvements in organisation.

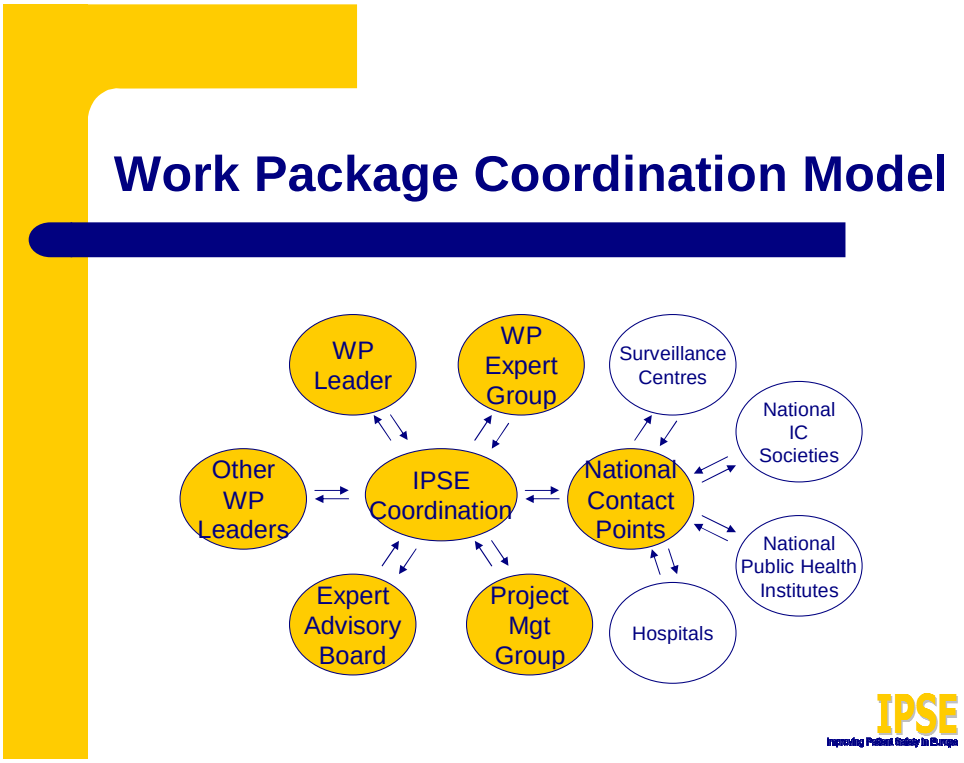
The grant from DG SANCO consisted of 4 lump sum payments;

- 30% on signature of the contract
- 20% on submission and acceptance of the first interim technical implementation report and consolidated financial statement (2005)
- 20% on submission and acceptance of the second interim technical implementation report and consolidated financial statement (2006)
- 20% on submission and acceptance of the final technical implementation report and consolidated financial statement (2005 - 2008)

It was the responsibility of the main partner to receive the lump sum payments and distribute them, as appropriate under the terms of the grant agreement, to the partners concerned.

1.2 Work Package Coordination

Although each work package was managed in specific ways according to the characteristics of the work involved, there were some characteristics common to the coordination of all of the work packages as follows;



The main features of work package coordination were as follows;

- Work Package leaders planned time schedule and resources for their work, in collaboration with the IPSE Coordination Team.
- Collaboration with other Work Package leaders took place where appropriate.
- A Work Package expert group supervised and reviewed the development of the work.
- National Contact Points participated in the development process. In this regard, their tasks were firstly elaborated in the work package descriptions of the contract. They also made contact with relevant experts in their country (ministries, agencies, professional societies, academic institutions) and solicited their point of view. Finally, the National Contact Points were responsible for validating work package deliverables.
- The achievement of each Work Package was evaluated on the occasion of Expert Advisory Board meetings.
- The progress of each Work Package, within the context of the overall project plan, was considered at Project Management Group meetings.

Ongoing coordination of activities largely took place via email and telephone.

Annual Plenary Meetings were used to effect review and control points for Work Package development involving network members. Benefiting from the large presence of the network members, Work Packages were able to support the prolongation of the Annual Plenary Meetings to include work group consensus meetings.

As far as possible, scientific conferences, in particular the annual ECCMID meetings, were also used as occasions to take contact within and between Work Packages.

1.3 Dissemination

The project website http://ipse.univ-lyon1.fr was used not only as a way of publishing project outcomes, but also as a vehicle for making the project development and consensus process more visible by making intermediate material available. Newsletters, published on the website, also described the work being undertaken and results being achieved.

The project used the occasion of scientific meetings and congresses, both national and international, to present work in progress and maintain contact with network members and the wider scientific community. Most significant were the ECCMID meetings in Copenhagen, Nice, Munich and Barcelona, which took place during the term of the project. The project was present at the European Network Corner on these occasions as well as contributions of individual work packages in the main congresses themselves. IPSE educational workshops were arranged in Nice and Munich ('Surveillance of ICU-acquired infections in Europe: overview of methodology, tools and results of the HELICS-ICU surveillance network', and, 'Healthcare-associated infection and antimicrobial resistance – a challenge for organisation and management', respectively).

The policy of the project was to publish results in scientific journals and this was achieved for a number of the work packages.

The annual plenary meetings held in Vienna were important occasions to build up the IPSE network participation and disseminate project outcomes. The final meeting held in Lyon in 2008 – 'The IPSE Symposium' – was oriented towards a presentation of the final project work towards the wider scientific community.

By combining these occasions with other IPSE meetings, a more efficient use of resources and a larger participation was achieved than would otherwise have been possible. So, workshops were also held on the occasion the annual plenary meetings in Vienna in 2005 and 2006 (**'**Training in HELICS standardised method for nosocomial infection surveillance', and, 'Using surveillance tools to support infection control', respectively). Project Management Group and Expert Advisory Board meetings also took place.

Internal project reporting to DG SANCO required technical implementation reports and consolidated financial statements for the periods of 2005, 2006 and 2007-2008. The project also produced annual reports intended for external readership, concerning the same time periods (including this report, the Final Report).

Under the terms of its founding mandate, the European Centre for Disease Prevention and Control (ECDC) became responsible for evaluating Disease Surveillance Networks as part of taking over responsibility for the surveillance of diseases. As part of this process, an ECDC hub visit took place in May, 2007 at the Coordination Office in Lyon, to evaluate the IPSE project, with a view to deciding on activities to be continued; either integrated within ECDC or outsourced, on conclusion of the project.

A further hub visit took place in June, 2008, to discuss and finalise the ECDC-IPSE Transition Plan and put the practical measures in place to effect this transition.

2.0 Raising Standards of Infection Control in Europe

2.1 Context and Background

Healthcare-associated infections (HCAI) affect an estimated 1 in 10 patients and lead to considerable increase in illness, mortality and costs. These infections are not constrained by national boundaries and can rapidly spread between countries as evidenced by international spread of MRSA as well as the SARS coronavirus.

Due to many reasons, it is expected that HCAI will constitute an increasing proportion of the overall burden of disease in European societies. For better control, consistent standards for monitoring and therapy should be used in Europe. However, considering that the existing level of the HAI and AMR differs within European countries and in order to contain further the spread of antimicrobial resistance and improve patient safety by prevention and control of HCAI, it may be appropriate to develop European standards of Infection Control.

There is a lack of comparable data worldwide on outcomes resulting from HCAI, including attributable mortality, prolongation of hospital care and the economic impact on individuals and health-care systems and societies. This information is a prerequisite for estimating the burden of HCAI, and is essential to empower health system managers, policy-makers, public health specialists and health-care workers to understand, prioritise, develop and implement solutions in relation to competing health threats.

To date, very few studies have provided information about the impact of costs of care for HCAI caused by a given antimicrobial-resistant pathogen in comparison to the antimicrobial-sensitive variant of the same pathogen. Furthermore, because of the wide variability of health systems in Europe, it is difficult to compare information from individual studies carried out in different countries.

Demonstrating the value of HCAI and AMR control activities to both caregivers and administration is essential. However, it is most important that patient care personnel perceive value in HCAI and AMR programmes; if they do, they will rely on the data for decisions and alter their behaviour in ways that should reduce the incidence of HCAI. By changing the behaviour of caregivers, HCAI and AMR programmes can actually improve the quality of patient care. Examination of complication rates (a more general approach than merely examining infection rates) and the “appropriateness” of medical interventions is of major interest to quality assurance personnel. This project suggests that inter-countries comparison of performance indicators of quality of medical care will be more useful if these indicators examine the utilization of practices that increase patients’ extrinsic risk and rates of adverse outcomes that attempt to control for exposure to the major risk factor(s) among patients with similar intrinsic risks. Failure to do so will certainly make inter-countries comparisons meaningless or even misleading.

2.2 Proposing Harmonised Standards and Indicators

The general outline of **IPSE Work Package 2** was to review existing guidelines, standards and indicators from Infection Control programs in the European Union and provide a manual of international standards for both HCAI and AMR. European countries have developed technical documents with recommended practices, but it was expressed by the IPSE Member States that it would be very helpful to develop an approach focusing on organisation, policies and structure on infection control at national and hospital levels.

The information collected by this project demonstrated the enormous differences within infection control programmes in the European region (annex 7). Valid and coherent standards of infection control should be able to better assess the economic impact of HCAI in all European Member States in a systematic manner, a consistent approach should be made to develop comparable standards of infection control in order to properly prevent and control HCAI and AMR.

A checklist for use at the level of hospital management level (annex 8) and a summary tool (annex 9) were developed to enable countries to check regularly the level of infection control measures at local level. A list of standards and recommended practices were developed with the aim of harmonising standards by helping countries to measure the occurrence and control capabilities in this area, and also by ensuring comparable information about HAI and AMR on national and European level (annex 10).

In recognition of the importance of HCAI and related problems of AMR, the Directorate General SANCO released a public consultation on strategies for improving patient safety by prevention and control of HCAI and increased standards of antimicrobial stewardship[1]. In addition they required that a consensus be explored for HCAI prevention and control standards and related performance indicators (SPIs) for monitoring the prevention and control of HCAI and AMR, as part of the IPSE project.

2.2.1 Objectives

- To help Member States (MS) measure the occurrence and control capabilities of HCAI and AMR.
- To develop and disseminate standards and indicators for national and local control capabilities of HCAI and AMR.
- To develop guidance for implementation and improvement of infection control practices at national and hospital levels.
- To develop training material to support the use of the guidance at the hospital level.
- To define a set of the developed indicators and include them into an internet based Geographic Information System

2.2.2 Methods

A European survey was performed, the results of which showed that there were many differences in the national Infection Control (IC) programmes of European countries and that there was indeed a need for a consensus of SPIs.

The original standards were written informed by the DG SANCO document and standards written previously[2]. These were then further developed into SPIs using a number of sources.

There were five categories for the SPIs, comprising organisational aspects, prevention and control policies, surveillance policies, education and training and resources for the control of HCAI and AMR. A 'Standard and Indicators' section described standards and corresponding indicators to measure and monitor progress for each of these five categories. The IPSE National Contact Points were asked to discuss and reach a consensus with nominated members of IC professional societies and other bodies

[1] Public consultation on strategies for improving patient safety by prevention and control of healthcare associated infections: http://ec.europa.eu/health/ph_threats/com/cons01_txt_en.pdf

[2] Cookson BD, et all. Standards in Infection Control in Hospitals, Report of a combined working party of the Association of Medical Microbiology, Hospital Infection Society, Infection Control Nurses Association and the Public Health Laboratory Service, HMSO, 1993: ISBN 0 901144 36 3.

considered to be appropriate. For example, one country, with which the guidance was piloted, consulted the steering group of its national surveillance system. However, MS Departments of Health (DoH) had already had the opportunity to comment on the public consultation document.

National Contact Points were asked to complete an adaptation of the Likert score[3]. These PIs comprised 13 national and 13 international PIs ("13+13"). These were sent to all IPSE National Contact Points encouraging them to distribute them with their WP2 collaborators. They were asked to score them in priority order and add comments as needs be. The results were analysed and presented at the final consensus meeting workshop and plenary session.

There were 138 Recommended Practices relating to these SPIs. A reduced set of performance indicators was developed by the Project group and sent to the Advisory Committee for further comments; however there was concern that a very much reduced set might be progressed. It was also thought to be important to develop and agree a validation process. It will be interesting to see how the Standards and Performance Indicators inform the discussions about to start within the EU.

2.2.3 Main achievements

Based on the results of the survey of the actual situation of health-care associated infections and antimicrobial resistant in the participating countries it became clear, that the heterogeneous infection control levels among countries and within countries make a unique European Guideline on Infection Control in Health Care Settings technically, politically and economically extremely difficult to achieve.

However, the development of a checklist for hospital management level about the level of infection control in individual hospitals was very well perceived and the opinion was that this could be practical and useful to offer through the countries to the hospitals. The checklist should be accompanied by a guideline on how to achieve the infection control requirements asked for in the checklist.

National governments can decide on collecting the information achieved through the checklist on the progress of each hospital at a later stage, keeping in mind, that the collection of this information might have an impact on the quality of the data compared with data from a self-evaluation that would stay in the hospital to judge its own level of infection control.

Mapping and geographic information systems were anticipated to a great and unique opportunity to integrate HCAI and AMR epidemiology and programme data in a way that draws attention to areas of change and its potential problems. As such they can should as operational tools for action oriented management and planning of programme interventions. Decision-makers can easily assess where the populations are in relation to specific problems and in relation to available official resources. In this way trends and interrelationships could be visually and spatially analysed The mapping system was presented during the 2008 IPSE plenary session to illustrate the situation in 2006 when the survey was performed. However, permission to show the data for each country had not been granted and in many their situation had since changed. Consequently, in accordance with the views of IPSE MS National Contact Point network and project coordinators, the decision was made not to present the material in the final report.

[3] 9. Likert, Rensis A technique for the measurement of attitudes, Archives of Psychology 1932; 140: 1-55.

2.2.4 Future perspectives

A remarkable level of agreement in SPIs has been achieved by IPSE WP2, probably the most extensive international exercise ever performed in this field. The SPIs were sent to DG SANCO who invited members of the group to join their core group drafting a document for the EU Council on HCAI prevention and control.

A local tool for use in hospitals has also been developed and was seen to be of value at IPSE plenary and ESCMID Conference workshops. A pilot is underway in a country that is using it at a national level. A mapping tool has also been developed.

As added value to the project a "cut-down" selection of performance ("13+13") indicators has been developed and a consensus achieved on prioritisation (all were considered to be important). This thus offers a relatively small number of indicators to infection control programmes at national and hospital levels and may be attractive to some? Some areas are included where issues were not able to be resolved (e.g. resourcing of the infection control team), but such an approach could help infection control professionals, healthcare workers, patients, policy makers and politicians to focus on key issues being faced.

Despite the amazing amount of knowledge accumulated during the past decades on infection control a considerable gap with current practices still exits worldwide. Breaches in infection control practices facilitate transmission of infection from patients to health care workers, other patients and attendants. The situation is worsened in settings with limitations in education and resources. Thus, healthcare settings often act as amplifiers of disease, with impact on the hospital and community health. HCAI was the primary accelerator of severe acute respiratory syndrome (SARS) infections, accounting for 55% to 72% of probable cases. The emergence of life-threatening infections such as (SARS) the risk of a new influenza pandemic highlight the urgent need for efficient infection control practices in health care targeted at severe acute respiratory diseases.

The need for clear, effective and implementable guidance on practicable and cost effective measures to control spread of infections is particularly important in stressful outbreak settings. Its aim is to assist health care facilities at local level to perform its functions even in outbreak situations.

Also the emergence and spread of antimicrobial resistance (AMR) is a major public health threat. There is a lack of data on the treatment outcomes in infections due to antibiotic resistant pathogens, in terms of attributable mortality, prolongation of hospital care and, above all, on the economic consequences for individuals and health-care systems and societies. This information, however, is a prerequisite for estimating the burden of resistance and disease, and is essential to empower health system managers, policy-makers, public health specialists and health-care workers to understand, prioritize, develop and implement solutions in relation to competing health threats.

Because of the wide variety of health systems in Europe, it is difficult to compare information from individual studies carried out in different countries. Providing realistic estimates of the burden of disease and the costs attributable to infections caused by antimicrobial resistant pathogens in member states and accession countries of the European Union is of paramount importance.

The development of training materials on infection control measures messages are critical for preparedness for control of spread of communicable diseases in healthcare settings, and will be among the key actions of the HCAI initiative for the next WHO/EURO biennium. It will generate the appropriate awareness and understanding of the societal dimension among policy-makers and communities at large, and act upon these issues. Both quantitative information and individual case histories will provide a realistic and complementary picture of the scope of HCAI and AMR in Europe.

2.3 Proposing Professional Development for IC Practitioners

2.3.1 Rationale

Training and status of IC physicians and nurses in the EU does not meet common standards. Differences result in very heterogeneous capacities of healthcare institutions to deal with surveillance, prevention and control of HAI.

2.3.2 Objectives

The objectives of **IPSE Work Package 1** were the following;

- Inventory and analysis of existing courses in infection control in all European member states:
  - Inventory of training procedures for IC nurses and physicians in the EU member states
  - Analysis of course content, duration and organisation

- Analysis of the professional status of infection control staff in all European Member States
  - Inventory of national/regional regulations (laws, guidelines, etc.) with regard to IC staff in hospitals and nursing homes (task description, minimal quota, governmental or other funding, accreditation, etc).

- Definition of a core curriculum for IC training in Europe:
  - Definition of a minimal common core curriculum for IC training with minimal content requirements for microbiology, epidemiology, nursing care, etc..
  - Core knowledge and competence acquired in the training curriculum of IC physicians and nurses

2.3.3 Methods

Within the framework of designing a consensual core curriculum, a survey was carried out in 28 European countries in collaboration with health care authorities and public health institutions. Participating countries were:

- 24 European Union Member States : Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovakia, Slovenia, Spain**,** Sweden**,** The Netherlands**,** United Kingdom
- 2 European Union Candidate countries : Croatia, Turkey
- 2 other European countries : Norway, Switzerland

In order to reach a consensual core curriculum which takes into account, on one hand, the national context and, on the other hand, the aspirations of the professional organisations, the survey was organised at two levels:

- National: A specific questionnaire on Infection Control professional profiles and national training programmes was addressed to the IPSE National Contact Points NCP. In addition to completing the National questionnaire, NCPs also designated the leading professional organisations dealing with Infection Control activities and/or training in their countries.
- Institutional: A specific questionnaire on characteristics, missions and aspirations regarding Infection Control tasks was addressed to the leading local organisations designated by the NCP.

Data collection took place from July to November 2006. Questionnaires were centralised, controlled and analysed by the IPSE Training Office (Lyon). The analyses allowed on one hand the description of the different profiles and training related to infection control in each European country and, on the other hand, the identification and selection of consensual professional tasks for both infection control doctors and nurses.

The design of the core curriculum was based on these consensual tasks. For each one of them:
- A suitable list of competencies was outlined.
- Foundation skills and knowledge were also taken into consideration.

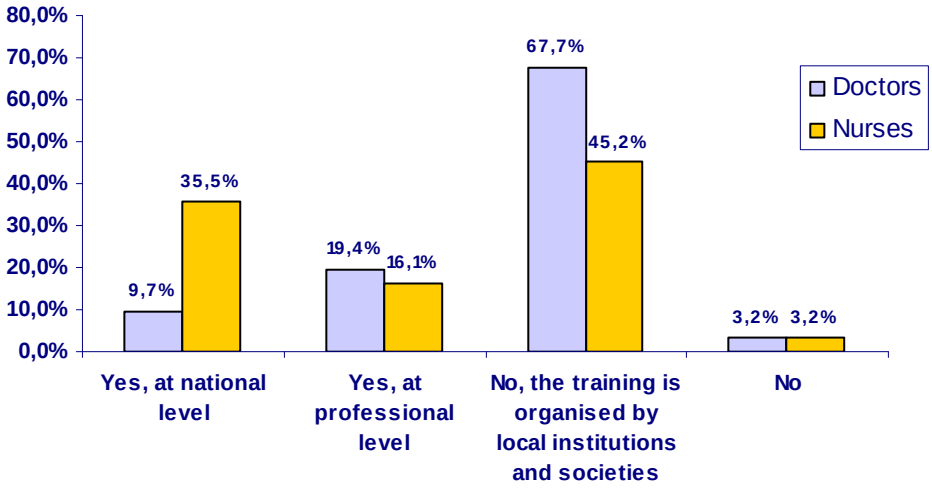
The development took place over an eighteen-month period and implicated the WP1 pedagogic committee, IPSE National Contact Points and representatives of the professional organisations who participated actively in reaching the consensus.

In parallel to the survey, research into existing infection control courses was performed. The aim was to identify pertinent training courses and to establish a European registry of doctors and nurses. The IPSE National Contact Points as well as the newly established network of professional organisations were associated with this collaborative task.

2.3.4 Results

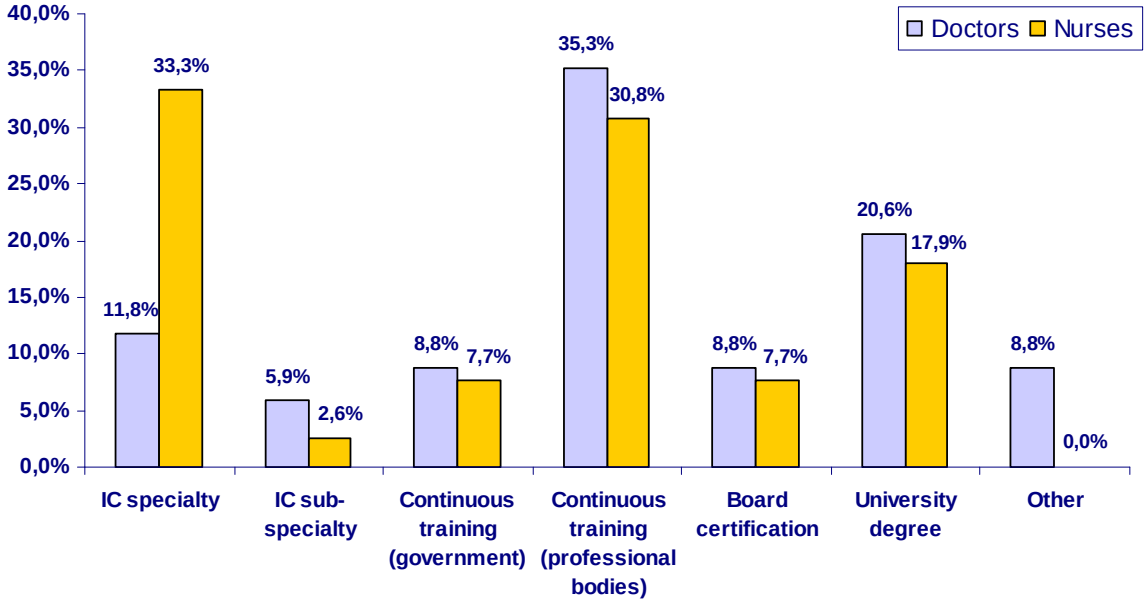
The survey indicates that infection control professionals do not have common training programmes or harmonised professional profiles: National training programs existed respectively in 55% of countries for nurses and 33% for doctors.

Figure 2.3.4.1: Existence of an official training program of IC practitioner profile



Few countries organised the qualification of IC practitioner in the framework of a specific specialty, but it was more frequent for nurses than for doctors. In one third of cases, the training was organised by professional bodies as a continuous training.

Figure 2.3.4.2: Type of degree or training leads to IC qualification



Regarding the definition of a professional profile for Infection Control practitioners, 18 countries (59%) define such a profile for doctors and 20 do so (66.7%) for nurses. It was defined by law, with specific governmental funding for doctors and nurses respectively in only eight and seven countries.

Figure 2.3.4.3: Definition of an official profile for infection control doctors

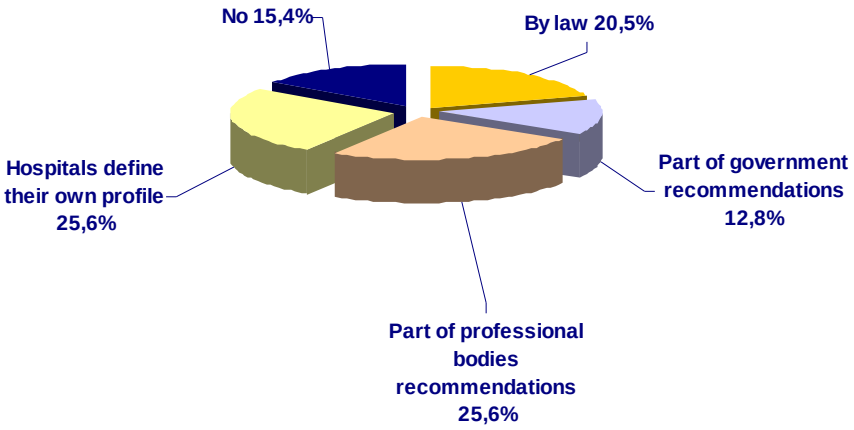
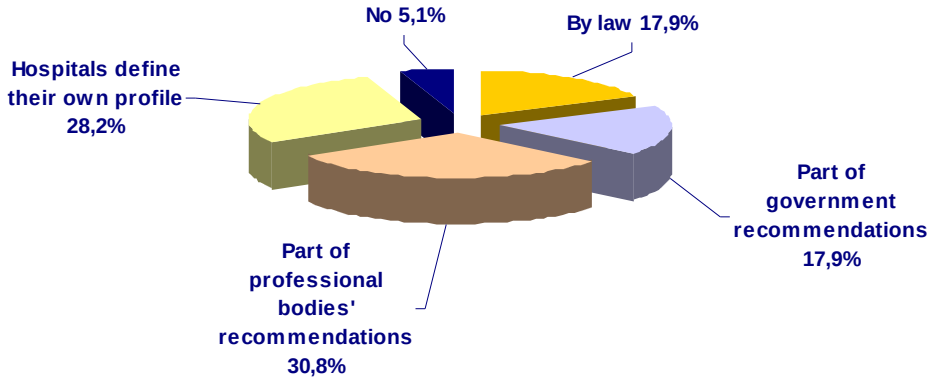


Figure 2.3.4.4: Definition of an official profile for infection control doctors



Defined ratios were available respectively in 50% and 65% of the countries for doctors and nurses (they were legally defined equally in 25 % of the countries). For doctors existing ratios varied from 1 Full Time Equivalent FTE/250 beds to 1/1000 beds, and for nurses from 1FTE/140 beds to 1/800beds.

One of the main objectives of the survey was to identify consensual professional tasks for the infection control practitioner. The consensual tasks (>60% of the countries) for doctors in terms of responsibility appeared to be; identification & investigation of outbreaks, analysis & feed back of Infection Control data, elaboration and management of the Infection Control programme, work plan & projects. The responsibilities of IC nurses were more concerned with training of hospital employees in Infection Control and elaboration of Infection Control procedures.

Figure 2.3.4.5 : Consensual professional tasks for infection control doctors

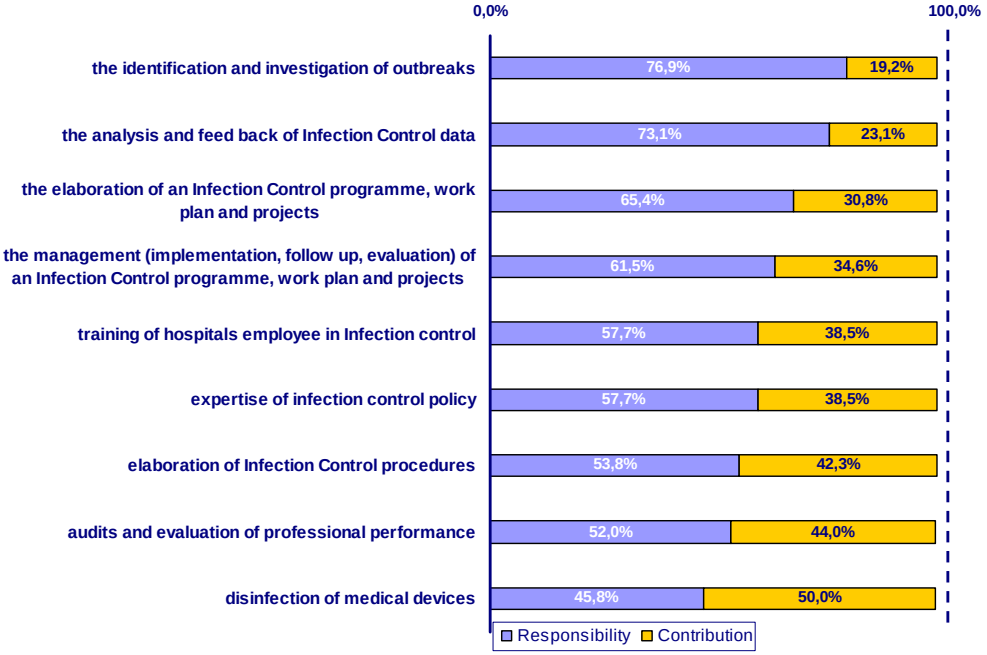
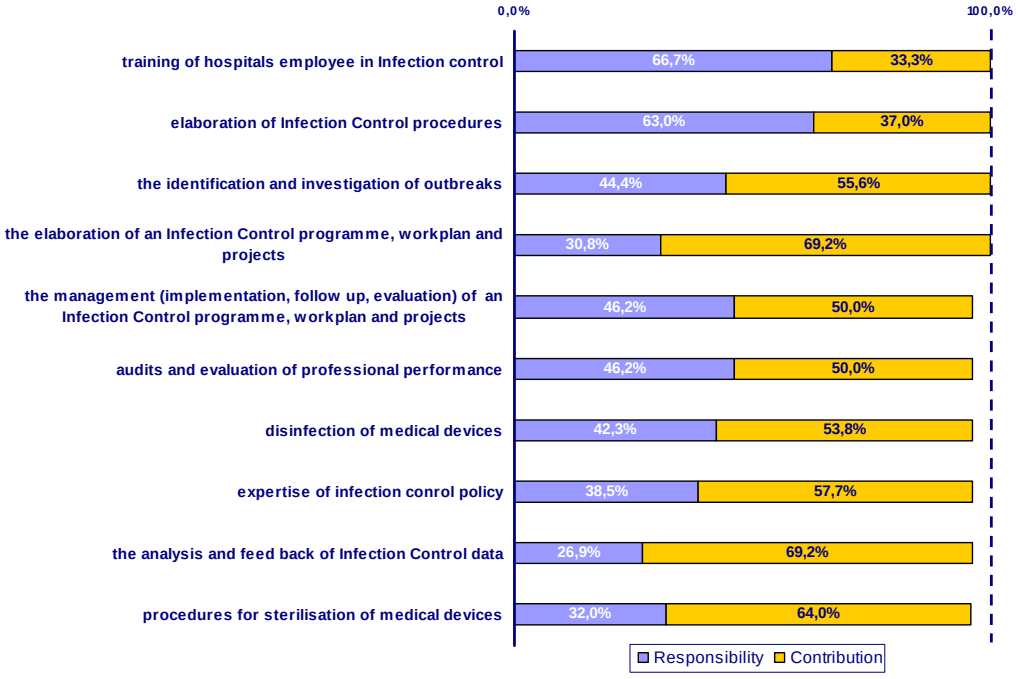


Figure 2.3.4.6 : Consensual professional tasks for infection control nurses



In addition, it appeared that the discipline is expanding with the inclusion of new components such as quality and risk management.

The elaboration of the core curriculum relied on the consensual tasks identified in the survey in order to formulate required competencies and basic knowledge and skills. After a long process of design, the core curriculum was organised into three components and consisted of 16 professional tasks and x competencies (see Table 2.3.4.1).

Table 2.3.4.1: Core Curriculum Synthesis

1. Programme Management (PM)	
Elaborating and advocating an infection control programme	PM 1
Managing an infection control programme, work plan and projects	PM 2
2. Quality Improvement (QI)	
Contributing to quality management	QI1
Contributing to risk management	QI2
Performing audits of professional practices and evaluating performance	QI3
Training of hospitals employees in Infection control	QI4
Contributing to research	QI5
3. Infection Control (IC)	
3.1. Surveillance and Investigation (SI)	
Designing a surveillance system	IC-SI1
Managing (implementation, follow up, evaluation) a surveillance system	IC-SI2
Identifying investigating and managing outbreaks	IC-SI3
3.2. Infection Control activities (ICA)	
Elaborating infection control interventions	IC-ICA1
Implementing infection control and healthcare Procedures	IC-ICA2
Contributing to reducing antibiotic resistance	IC-ICA3
Advising appropriate laboratory testing and use of laboratory data	IC-ICA4
Decontamination and Sterilisation of medical devices	IC-ICA5
Controlling environmental sources of infections	IC-ICA6

The core curriculum corresponded to both infection control doctors and nurses; almost all the tasks (except reducing antibiotic resistance, only for doctors) were common to both of them. The training level would correspond to a master degree (first level) and to a one year of education (including theory and practice).

As regards the registry of existing training courses dedicated to infection control, 26 nursing and 31 medical courses were reported. Training was organised by universities, schools of public health, professional bodies or national societies. It was variously delivered in the different countries (via diplomas, continuous education courses, modules in the framework of a defined specialty, scientific seminars or workshops).

2.3.5 Future perspectives

On one hand, the core curriculum is aimed at professional organisations responsible for training ICPs as well as healthcare institutions which define on their own ICP profiles (particularly in countries where no national training or curriculum exists). At this level, the proposed curriculum would be used as a reference for adapting and improving existing training programmes.

On the other hand, the proposed curriculum would also be the base for initiating a European dialogue on qualification/specialisation of ICPs. Indeed, if expressed as a common desire of European Member States, the survey carried out to collect the information, the registry of national training programmes already established and the proposed consensual core curriculum could together constitute the start of the process. In addition, within the framework of the proposed European Council Recommendation on improving patient safety by the prevention and control of healthcare associated infections, in progress with a DG SANCO remit, inclusion of a reference related to IC training and particularly to a European core curriculum proposal could be also an important indication for European countries.

3.0 Strengthening European Surveillance of HCAI

3.1 Context and Background

The HELICS project (Hospitals in Europe Link for Infection Control through Surveillance) is a network of national/regional networks for the surveillance of nosocomial infections and was set up in 2000 in the context of the Decision 2119/98 of the European Parliament and Council on the surveillance of Communicable Diseases. The two core activities of HELICS are the surveillance of nosocomial infections in the ICU and the surveillance of surgical site infections. In 2000-2001, an analysis of existing protocols for the surveillance of ICU-acquired infections was carried out and formed the basis of a new EU protocol and data format set up in 2002 and concluded in February 2003, including a minimal data set (level 1 surveillance) and a patient-based dataset (level 2 surveillance) (HELICS Implementation Phase I report, June 2002, and HELICS-ICU Protocol V.6.1, October 2004, http://helics.univ-lyon1.fr). The protocol has been stable since. The detailed comparative analysis of the methods of the existing national surveillance networks for as published in the 2002 (HELICS implementation phase I, final report, chapter 7, pp 24-53, available at http://ipse.univ-lyon1.fr/about/final_report.pdf).

HELICS gathers surveillance data from the national networks for surveillance of nosocomial infections. The coordination of the surveillance of nosocomial infections is usually performed by the national surveillance institutes or by other institutions (such as universities) that have been designated for that task by the National Health authorities or surveillance institutes. In countries with a strong regionalisation of hospital infection control policies, setting up coordinated national initiatives for HCAI surveillance is a difficult process (e.g. Sweden) and in some cases the initiative for setting up a network has been led by national societies for infection control without formal collaboration with the national institute (e.g. Italy, Poland). The table shows an overview of coordinating institutes with their respective websites for a selected number of countries.

Table 3.1.1 Overview of HCAI surveillance networks and coordinating institutes with their respective websites

Country	Network acronym	Coordination Website
Austria	ANISS	Austrian Nosocomial Infection Surveillance System, Medical University of Vienna www.meduniwien.ac.at/hygiene/?c=aniss&s=krankenhaushygiene
Belgium	NSIH	National Surveillance of Healthcare-associated infections and antimicrobial resistance, Scientific Institute of Public Health (IPH), Brussels www.iph.fgov.be/nsih
Croatia		Reference Centre for Hospital Infections, Zagreb
Finland	SIRO	Finnish Hospital Infection Programme (SIRO), National Public Health Institute (KTL), Helsinki www.ktl.fi/siro
France	RAISIN	Réseau d'Alerte, d'Investigation et de Surveillance des Infections Nosocomiales (RAISIN), under the auspices of the Insititut de Veille Sanitaire (InVS) www.invs.sante.fr/raisin
FR-East	C.CLIN Est	www.cclin-est.org
FR-Paris-Nord	C.CLIN Paris-Nord	www.cclinparisnord.org
FR-South-east	C.CLIN Sud-Est	www.cclin-sudest.chu-lyon.fr
FR-South-west	C.CLIN Sud-Ouest	www.cclin-sudouest.com
FR-West	C.CLIN Ouest	www.cclinouest.com
Germany	KISS	German Nosocomial Infection Surveillance System (KISS), National Reference Centre for Nosocomial Infection Surveillance, Charité Medical University, Berlin www.nrz-hygiene.de/surveillance/surveillance.htm
Hungary		Johan Béla National Centre for Epidemiology, Budapest www.oek.hu/oek.web*
Italy	SPIN-UTI	Regional Health Authority of Emilia-Romagna, Bologna; ICU network: Gruppo Italiano Studio Igiene Ospedaliera (GISIO)
Lithuania		Institute of Hygiene, Vilnius www.hi.lt=> Hospitalinės infekcijos

Table 3.1.1 Overview of HCAI surveillance networks and coordinating institutes with their respective websites (cont.)

Country	Network acronym	Coordination Website
Luxembourg	NOSIX	Centre de Recherche Public de la Santé, Luxembourg www.crp-sante.lu*
Netherlands	PREZIES	Prevention of Nosocomial Infection through Surveillance (PREZIES), National Institute for Public Health and Environment (RIVM) and the Dutch Institute for Healthcare Improvement (CBO) www.prezies.nl
Norway	NOIS	Norwegian Institute of Public Health (FHI), Oslo www.fhi.no=> NOIS
Poland		Polish Society of Hospital Infections; National Institute of Public Health, Warsaw
Spain	ENVIN (ICU), EPINE (prevalence)	Envin: Hopital Val d'Hebron, Barcelona; SSI surveillance by Carlos III Institute of Health, Madrid www.mpsp.org/mpsp/epine; www.iscii.es*
Portugal	HELICS-UCI	
UK-England	SSISS (SSI)	Health Protection Agency (HPA), London www.hpa.org.uk/infections/topics_az/hai/default.htm
UK-Northern Ireland	HISC	Northern Ireland Healthcare-associated Infection Surveillance Centre (HISC), Belfast www.hisc.n-i.nhs.uk
UK-Scotland	SSHAIP	The Scottish Surveillance of Healthcare Associated Infection Programme (SSHAIP), Health Protection Scotland, Glasgow www.hps.scot.nhs.uk/haiic/sshaip/index.aspx
UK-Wales	WHAIP	Welsh Healthcare Associated Infection Programme (WHAIP), National Public Health Service (NHS) Wales www.wales.nhs.uk/sites3/home.cfm?orgid=379

* websites without specific pages for HCAI surveillance.

From November 2003 until October 2004, a pilot EU database was constituted from existing national databases from 2000 to 2003 and showed that many of the existing data could be converted into the new HELICS format, although the compatibility was far from being perfect and large differences in definitions used both for infections as risk factors and denominator data remained to be resolved. In 2003 and 2004, several countries started to make adaptations to their national protocols to improve compatibility with the HELICS protocol (HELICS implementation phase II). This process continued during the following years (2005-2007), while countries starting new surveillance networks used HELICS-compatible methods from the start.

3.2 HELICS Surveillance

3.2.1 Sustaining and extending surveillance

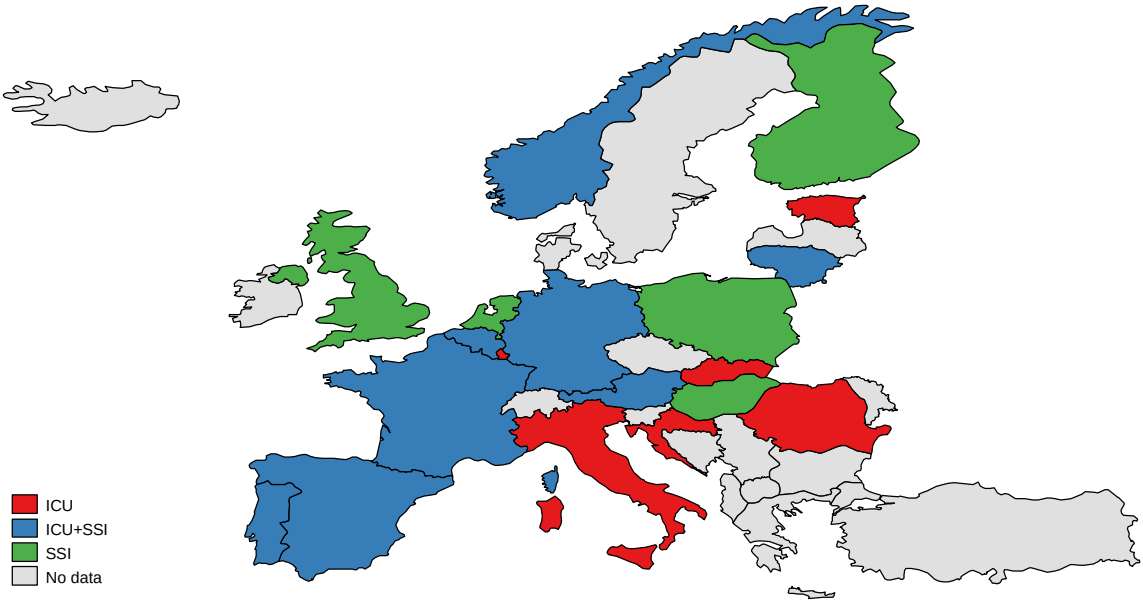
The process of extending HELICS surveillance including training and the continued support for minimal data collection and analysis were the main objectives of **IPSE Work Package 4**. Extension of surveillance was mainly sought through inviting all EU member states' and candidate countries' delegates to the IPSE network meetings and HELICS surveillance training courses (see below), formally inviting all countries to submit data for either of the surveillance protocols or both, promoting IPSE/HELICS surveillance at key European conferences (ECCMID – Copenhagen 2005, Nice 2006, Munich 2007 and the 2006 Hospital Infection Society Conference in Amsterdam) and through scientific publications, presentations at national conferences.

Further support to the surveillance networks was realised in through:

- Network meetings
- The yearly 2-days IPSE network meetings included parallel meetings of the HELICS-SSI and HELICS-ICU surveillance networks. Other HELICS meetings were held at ECCMID and ESICM conferences.
- Offering standardised surveillance tools including free software tools for hospitals and network coordinators.

Compared to the end of the first phase of the HELICS project in 2003, the number of national/regional networks for surveillance of surgical site infections that reported data to IPSE/HELICS increased from 8 to 16 (Austria, Belgium, Finland, France, Germany, Hungary, Lithuania, The Netherlands, Norway, Poland, Portugal, Spain, United Kingdom, composed of 4 separate networks – England, Wales, Scotland and Northern Ireland) in 2007. The number of national/regional networks for surveillance of nosocomial infections in intensive care units increased from 7 to 10 in 2007 (Austria, Belgium, Germany, France, Italy, Lithuania, Luxemburg, Portugal, Spain, Slovakia), with another 7 countries piloting in 2007 or 2008, of whom some submitted pilot data (Norway, Estonia, Romania, Croatia). The map below shows countries having submitted data for either of the 2 Helics surveillance protocols, full network data and pilot data combined, during 2005-2007 (2004-2006 data). It shows that some "older" EU Member States (Republic of Ireland, Sweden, Greece and Denmark) still have not developed HCAI surveillance, with Denmark being the pilot country in the EU who developed SSI surveillance in the eighties, but has discontinued it in 2003. It should also be mentioned that Ireland, Sweden and Denmark, as well as other countries with missing surveillance data such as Bulgaria, Slovenia, and Latvia did recently organise HCAI prevalence surveys. The Czech Republic reportedly adopted a hospital-wide protocol for the surveillance of bloodstream infections, which would also allow it to contribute the minimal dataset for ICU surveillance in the near future. Greece did not report any HCAI surveillance network data to the EU level in 2005-2007, although a regional HCAI surveillance network is functioning well in Crete, includes hospitals from all over the country and has established collaboration with another missing EU country (Cyprus). Other countries (Sweden, Malta, Czech Republic, Turkey) who did not report to HELICS, did report data to CARE-ICU (IPSE work package 5) that will progressively be integrated with HELICS-ICU to form a single integrated ICU surveillance module (covering infection, resistance and antibiotic use data).

Figure 3.2.1.1 Countries with HELICS surveillance of surgical site infections and/or ICU-acquired infections in 2007



In summary, when including participation in the other IPSE surveillance Work Packages, 7 countries (Republic of Ireland, Denmark, Latvia, Slovenia, Bulgaria, Greece and Cyprus) did not submit data to the EU level during the duration of the IPSE project, 17 MS and 2 EEA/Candidate countries submitted data to HELICS, and an additional 3 MS and 1 candidate country submitted data to Care-ICU only.

Even if a lot has been achieved, the process of extending surveillance in the EU is rather slow because it often requires important political decisions and an investment in at the national and hospital level in setting up or reinforcing infection control programmes including surveillance. Countries may also decide to concentrate their investments and efforts in the field of infection control on one or several other aspects such as process indicators (e.g. hand hygiene compliance or alcohol rub consumption), other methods (e.g. nosocomial infection prevalence surveys), other infection types (e.g. surgical site infections or hospital-wide surveillance of bloodstream infections), pathogen-specific surveillance (e.g. *Clostridium difficile*, multiresistant nosocomial pathogens such as MRSA, VRE or ESBL producing *Enterobacteriaceae*) or other risk groups (e.g. dialysis patients, maternity, hospital-wide central line surveillance, nursing homes etc.). HELICS' choice to concentrate standardization efforts on only two of these possible protocols (SSI and ICU) was based on the fact that these types of surveillance networks were most prevalent EU-wide in the late nineties, when the project proposal was being prepared for submission to the EC Public Health Programme. Despite the European legislation (Decision 2119/98 EC) mentioning explicitely "nosocomial infections" as a special health issue to be included in the EU-wide surveillance of communicable diseases, the impact of the disease surveillance network (DSN, HELICS followed by IPSE) on national decision makers is rather limited to incite Member States' national or regional governments to provide funding and possibly legislation for national infection control programmes including surveillance of ICU-acquired infections and surgical site infections according to the agreed methodology within the DSN. It may be anticipated that the ECDC supported by the European commission would be more successful in this process. Therefore, and because of the fact that nosocomial infections constitute a major public health issue with an estimated 4.1 million of infected patients every year in European hospitals and more than 37000 attributable deaths, the transfer of surveillance of nosocomial infections to ECDC should be recommended.

Since 2004, countries without an ICU surveillance network have started full (Lithuania) or pilot national/regional surveillance networks according to the new HELICS-ICU protocol (e.g. Norway, Slovakia, Italy, Scotland, Romania, Croatia, Hungary).

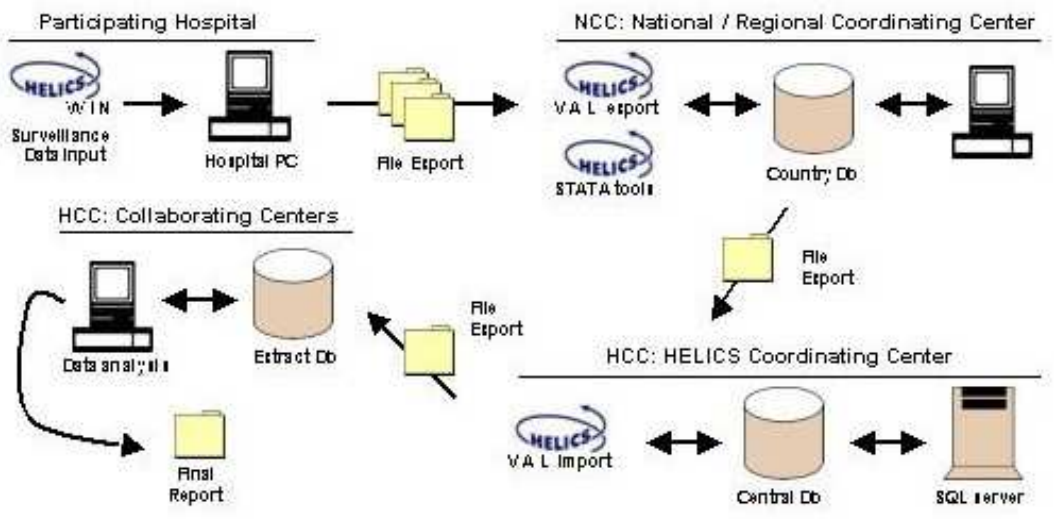
3.2.2 Training and technical support

During the course of the project 5 training seminars were organised. Two seminars were organised in Vienna, back to back with the IPSE network meetings hosted by the Austrian Federal Ministry of Health and Women.

Dates	Venue	Seminar Title
24-25/11/2005	Vienna, Austria	Training course in Helics standadized method for nosocomial infections surveillance
1/04/2006	Nice, France,16th ECCMID	Workshop: European Surveillance of Nosocomial Infections, Antimicrobial Resistance and Antimicrobial Use in Intensive Care Units
14-15/11/2006	Vienna, Austria	Using surveillance tools to support Infection Control
31/3/2007	Munich, Germany, 17th ECCMID & 25th ICC	Healthcare-associated Infection and Antimicrobial Resistance – a challenge for organization and management
24-25/5/2007	Brussels, Belgium	HELICS/IPSE ICU surveillance: methods and software tools

During the 3 2-days courses in Vienna and Brussels HELICS surveillance methods were reviewed by means of lectures and case studies, as well as reviewing the software tools developed for HELICS surveillance. Specifically, the software development followed the data-flow organization and data specification rules as contained in the HELICS Operating Manual and the HELICS-ICU and HELICS-SSI surveillance protocols.

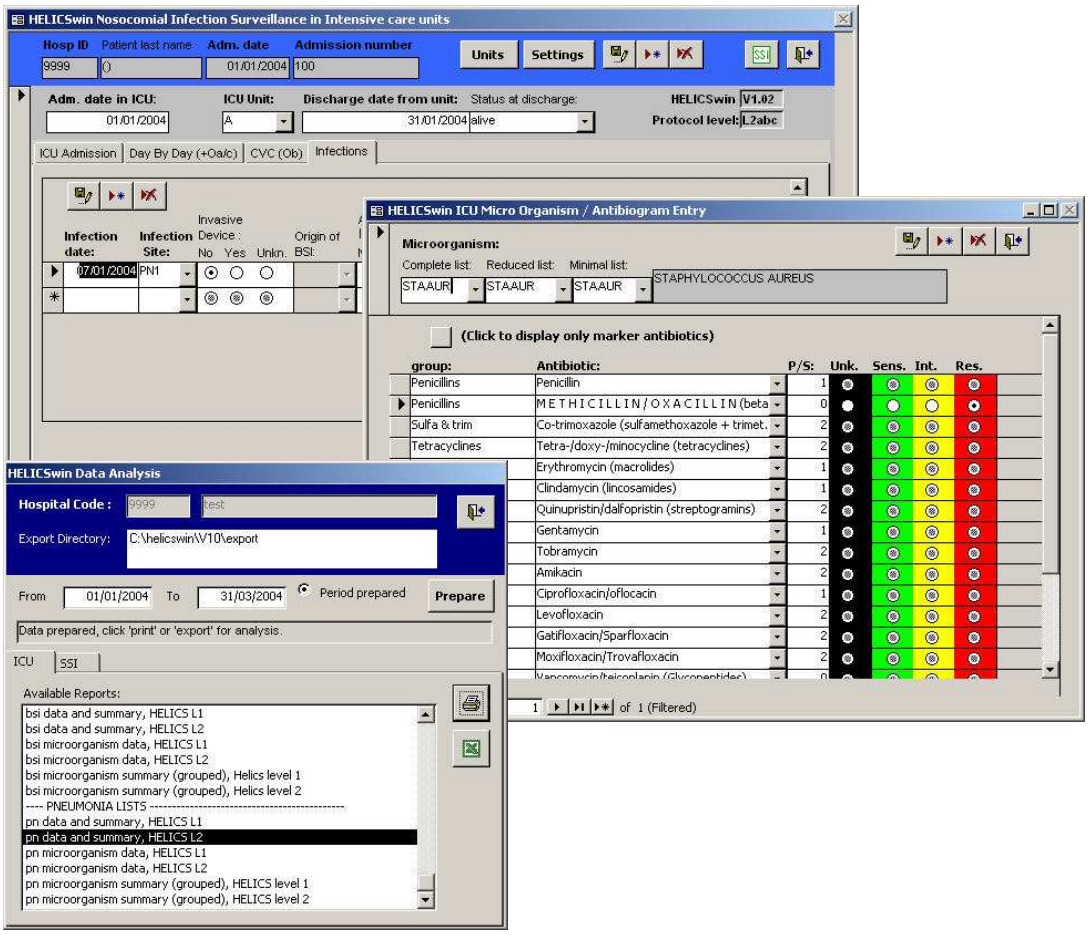
Figure 3.2.2.1 HELICS data flow and corresponding software tools



In support of hospitals participating in HELICS surveillance, **the HELICSwin software** (figure 3.2.2.1) provides:

- Manual input of data of surveillance of ICU-acquired infections and surgical site infections.
- Analysis and export of data for send-up to the organizing network.
- The automatic import of surveillance data from Microsoft Excel format.
- The possibility to translate its interface to a language of interest.

Figure 3.2.2.2 Screenshots of HELICSwin software for use at the hospital level

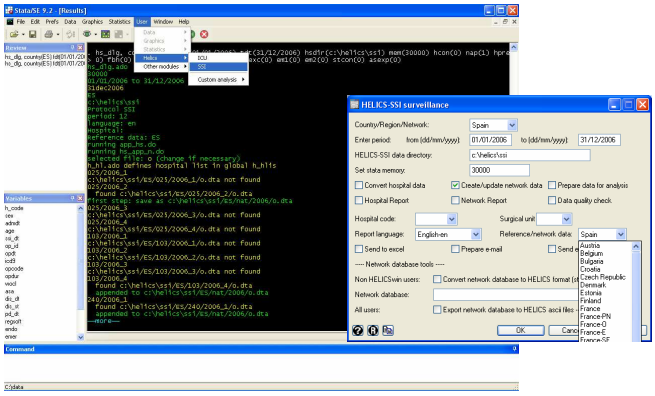


HELICSwin screens, top to bottom: ICU infection data entry, antimicrobial resistance data entry, analysis module

To assist networks in the set up of a national or regional database, the HELICS STATAtools software enable:

- Automatic appending of HELICSwin hospital export files into a national or network database.
- Automatic creation of multilingual analysis reports containing detailed feedback on the hospital, national or regional level.

Figure 3.2.2.3 Screenshots of HELICS Stata tools for use at the network coordination level and feedback report to participating hospital



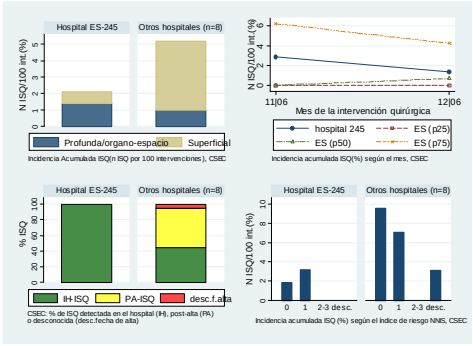


Table III. Incidence density (# in-hospital SSI/1000 post-op pt.days)

	N days (1)	Inc Dens (2)	95% CI (3)	P (4)	ES, N (5)	ES, mean (6)	ES, mean (7)	P10	P25	P50	P75	P90
COLO	13|1551	8.4	(4.5-14.3)	P17	89|5193	17.1	20.2	8.4	11.5	20.5	23.1	37.3
NNIS 0	.|.	.	(.- .)	P.	10|599	16.7	15.8	5.6	5.6	20.2	21.7	21.7
NNIS 1	6|577	10.4	(3.8-22.6)	P17	30|1819	16.5	25.7	10.4	15	23.7	37	44.4
NNIS 2-3	7|974	7.2	(2.9-14.8)	P33	43|2565	16.8	14.6	0	7.2	12.4	18.3	37.2
NNIS unk.	.|.	.	(.- .)	P.	6|210	28.6	31.4	27	27	27	40	40

(1)-(4) Results for your hospital (1) Number of in-hospital SSI | N of post-operative patient-days in hospital,
(2) Inc Dens=incidence density=N in-hospital SSI/1000 post-op pt.days, (3) 95% confidence interval, (4) Percentile,
(5) Reference data ES, N of in-hosp SSI|N of post-op. pt.days, (6) ES database mean: global incidence density,
(7) ES mean of means (equal weight for each hospital)
CABG=Coronary Artery Bypass Graft (=GBGB+CBGC), CHOL=Cholecystectomy, COLO=Colon surgery,
CSEC=Caesarian Section, HPRO=Hip Prosthesis, KPRO=Knee Prosthesis, LAM=Laminectomy

STATAtools HELICS-SSI reports, clockwise: cover page of a virtual hospital report, graphical part extract, table part extract (hospitals own results compared to national percentile distributions)

3.2.3 Summary of results

Results of HELICS SSI surveillance, 2004-2006

From 2004 to 2006, data on surgical site infection (SSI) surveillance were received from 16 networks in 13 countries and included in total 521,186 surgical interventions. In 2006 only, 238 550 surgical interventions from 1 033 hospitals (compared with 138 893 interventions and 765 hospitals in 2005) were received. The types and numbers of operations reported by each country are given in table 3.2.3.1.

Table 3.2.3.1 Number of interventions included in the HELICS-SSI surveillance by category and country in 2004-2006

	CABG	CHOL	COLO	CSEC	HPRO	KPRO	LAM	Total
Austria	779	131	25	1,973	3,079	768	130	**6,885**
Belgium	295	138	370	187	947	236	395	**2,568**
Finland	0	0	0	0	11,026	3,750	0	**14,776**
France	1,545	18,930	11,853	23,787	16,496	10,088	3,735	**86,434**
Germany	16,864	25,851	13,203	33,156	48,119	22,422	6,534	**166,149**
Hungary	0	2,735	832	2,074	1,933	0	119	**7,693**
Lithuania	2,410	3,274	670	1,418	474	0	0	**8,246**
Netherlands	0	1,304	1,627	2,328	14,638	6,341	303	**26,541**
Norway	780	408	0	2,228	2,162	0	0	**5,578**
Poland	790	6,769	1,823	4,974	3,704	494	602	**19,156**
Portugal	2	3,016	1,078	1,973	1,112	0	104	**7,285**
Spain	268	736	768	1,083	1,295	380	110	**4,640**
England (UK)	12,460	0	4,779	0	61,667	33,683	0	**112,589**
N Ireland (UK)	0	0	0	0	6,544	2,258	0	**8,802**
Scotland (UK)	0	0	0	11,021	13,774	8,133	0	**32,928**
Wales (UK)	0	0	0	3,624	4,089	3,203	0	**10,916**
Total	**36,193**	**63,292**	**37,028**	**89,826**	**191,059**	**91,756**	**12,032**	**521,186**

Source: HELICS-SSI network.
Note: CABG Coronary artery bypass graft, CHOL Cholecystectomy, COLO Colon surgery, CSEC Caesarean section, HPRO Hip prosthesis, KPRO Knee prosthesis, LAM Laminectomy.

The percentage of surgical site infections varied according to the type of surgical intervention with the highest cumulative incidence in colon surgery (8.5%) to less than 1% in laminectomy and knee prosthesis. SSI rates increased with increasing NNIS risk indices in cholecystectomy, colon surgery, hip and knee prosthesis, but were not well correlated in coronary artery bypass graft and C-section (figure 3.2.3.2), indicating the need to develop adapted risk adjustment tools for these interventions.

Table 3.2.3.2 Cumulative incidence (% SSI) per operation category with European percentile distribution, HELICS-SSI 2004-2006

	N SSI (1)	N of hosp.	N op. (2)	%SSI (3)	95% CI (4)	Mean (5)	P10	P25	P50	P75	P90
CABG	1012	59	35708	2.8	(2.7-3.0)	3.3	0	1.3	2.6	4.3	6.8
CHOL	734	364	59063	1.2	(1.2-1.3)	1.2	0	0	0	1.7	3.7
COLO	2784	270	32607	8.5	(8.2-8.9)	8.3	0	2.4	6.9	12	18.2
CSEC	2615	309	88502	3	(2.8-3.1)	2.7	0	0	1.3	3.2	7.5
HPRO	3038	600	186742	1.6	(1.6-1.7)	1.9	0	0	1.1	2.7	5
KPRO	747	373	88989	0.8	(0.8-0.9)	0.8	0	0	0	1.1	2.4
LAM	64	53	10356	0.6	(0.5-0.8)	1.1	0	0	0	0.7	3.2

(1) Number of SSI within 30 days or 1 year if HPRO/KPRO.
(2) Number of interventions.
(3) Cumulative incidence=N SSI/100 interventions (database mean).
(4) 95% confidence interval.
(5) EU mean of means (equal weight for each hospital) ; CABG=Coronary Artery Bypass Graft (=CBGB+CBGC), CHOL=Cholecystectomy, COLO=Colon surgery, CSEC=Caesarian Section, HPRO=Hip Prosthesis, KPRO=Knee Prosthesis, LAM=Laminectomy.

Figure 3.2.3.1 Cumulative incidence of surgical site infections per operation category and NNIS risk index, HELICS-SSI, 2004-2006

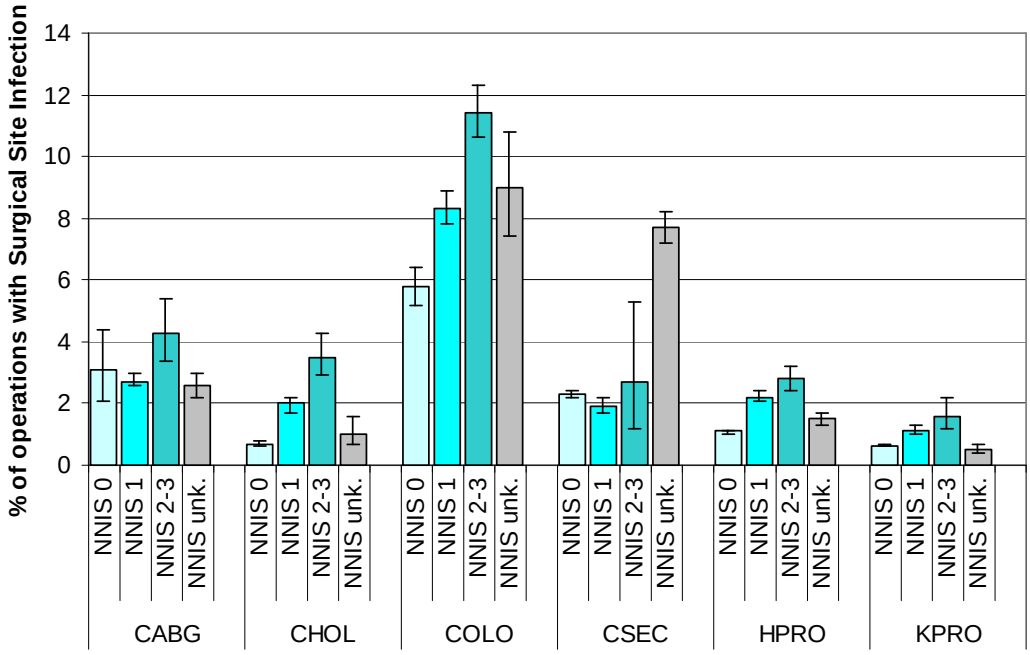


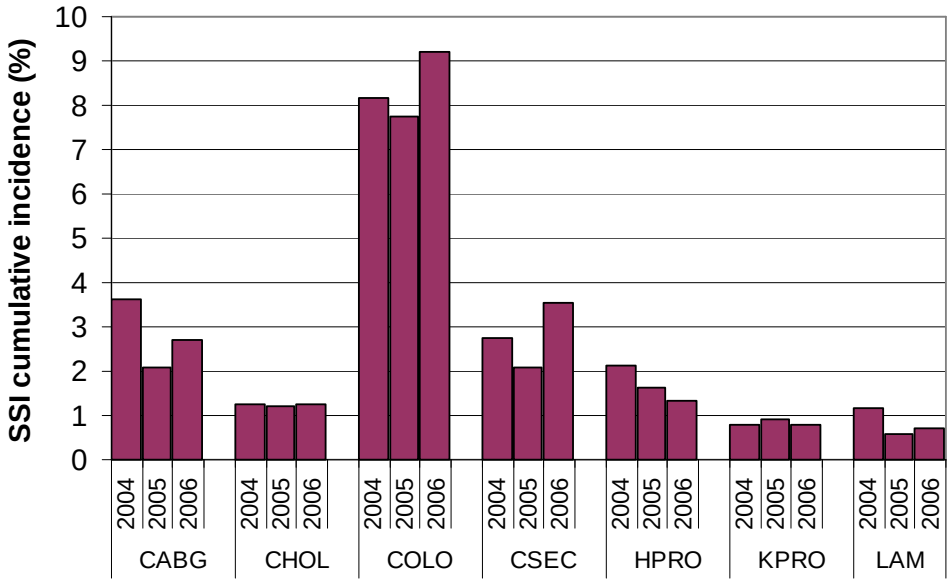
Table 3.2.3.3 SSI incidence density (n of in-hospital SSI/1000 post-operative patient days) per operation category with European percentile distribution, HELICS-SSI 2004 - 2006

	N SSI IH (1)	N days (2)	Inc Dens (3)	95% CI (4)	Mean (5)	P10	P25	P50	P75	P90
CABG	602	273837	2.2	(2.0-2.4)	2.9	0	0.6	1.6	3.4	5.7
CHOL	342	209283	1.6	(1.5-1.8)	3.7	0	0	0	1.8	5.5
COLO	2000	320168	6.2	(6.0-6.5)	7.4	0	1.6	5.2	8.7	14.2
CSEC	955	412230	2.3	(2.2-2.5)	5.3	0	0	0.5	2.6	6.6
HPRO	1737	1555834	1.1	(1.1-1.2)	1.4	0	0	0.4	1.6	3.2
KPRO	270	661145	0.4	(0.4-0.5)	0.5	0	0	0	0.5	1.4
LAM	26	40790	0.6	(0.4-0.9)	3.3	0	0	0	0.4	6.3

(1) Number of in-hospital SSI.
(2) N of post-operative patient-days in hospital.
(3) Inc Dens=incidence density=N in-hospital SSI/1000 post-op pt.days (database mean)
(4) 95% confidence interval.
(5) EU mean of means (equal weight for each hospital) ; CABG=Coronary Artery Bypass Graft (=CBGB+CBGC), CHOL=Cholecystectomy, COLO=Colon surgery, CSEC=Caesarian Section, HPRO=Hip Prosthesis, KPRO=Knee Prosthesis, LAM=Laminectomy

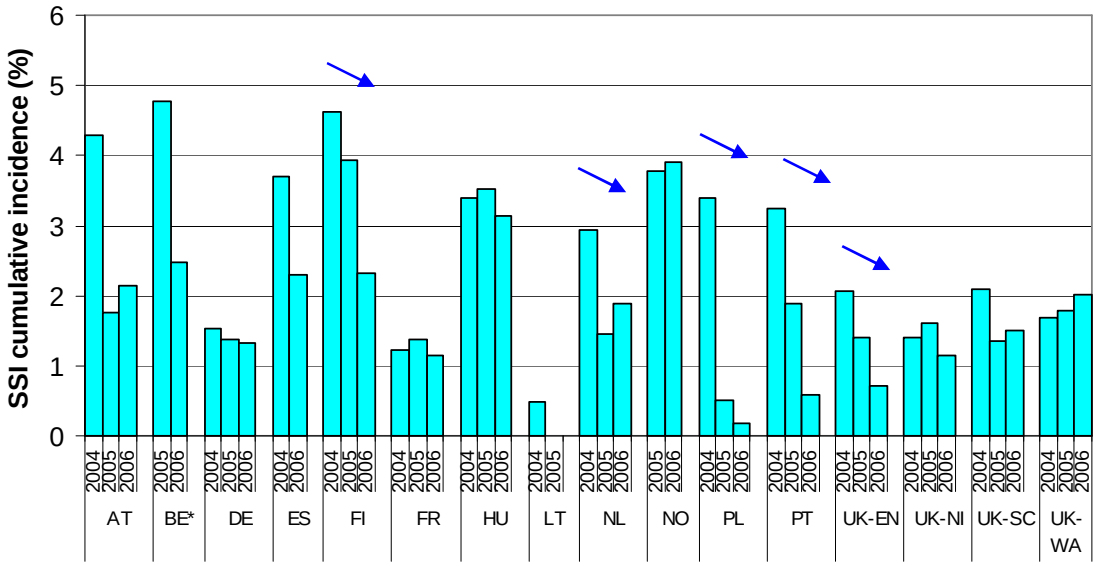
SSI rates in 2006 remained stable except for hip prosthesis operations (HPRO) where a significant decreasing trend can be observed; from 2.2% in 2004 to 1.6% in 2005 and 1.3% in 2006 (p = 0.039) (Figure). This decrease in HPRO infections was most significant in England and Finland (Figure 3.2.3.3), and was confirmed when adjusting for the length of stay in the hospital by trend analysis of the incidence density.

Figure 3.2.3.2 Trends in cumulative incidence of surgical site infections in Europe by operation category, 2004–06



Source: HELICS-SSI. Arrows indicate significant decrease in surgical site infection rates in hip prosthesis

Figure 3.2.3.3 Trends in cumulative incidence of surgical site infections in hip prosthesis (HPRO) by country, 2004–06

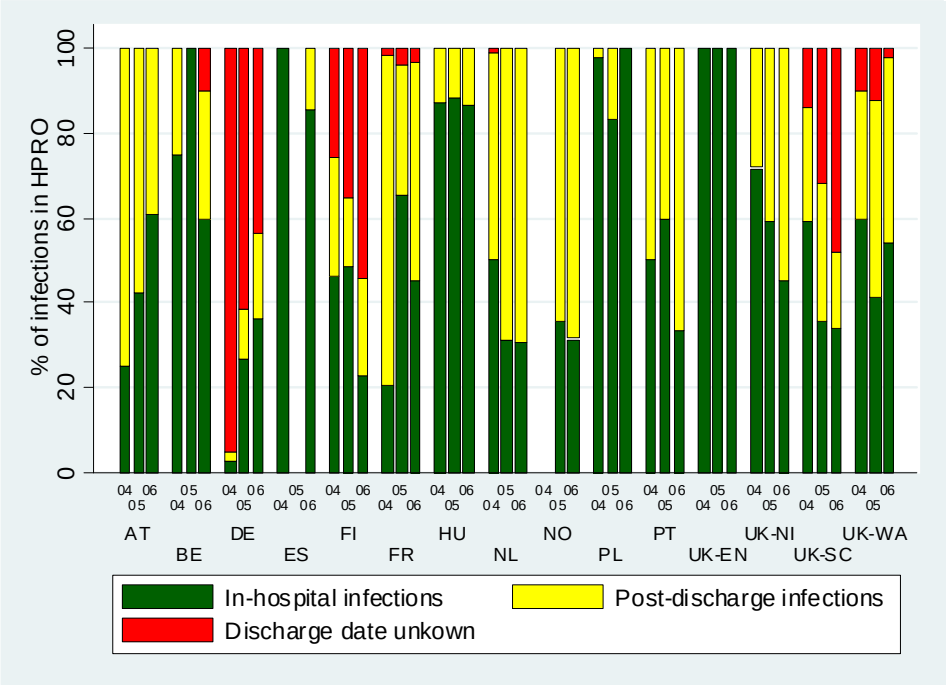


Source: HELICS-SSI. Arrows indicate significant decrease in surgical site infection rates in hip prosthesis

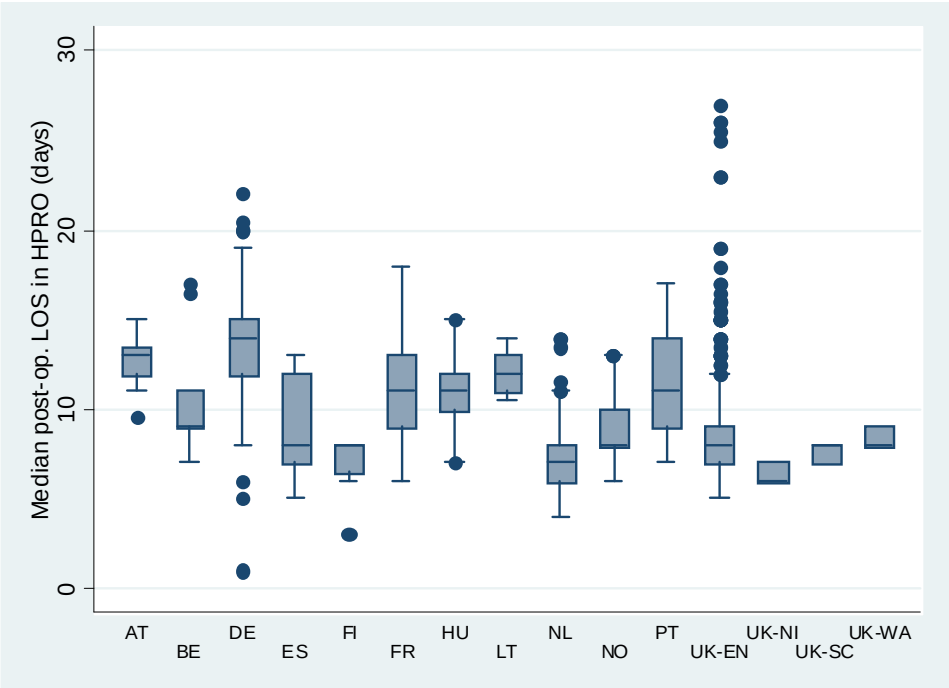
*Data for Belgium in 2004–05 were pooled because of the numbers in individual years were too few; Lithuania did not provide data on HPRO in 2006; 2005 data from Portugal, Poland and the Celtic network (UK-NI, UK-WA and UK-SC) were sent after the publication of the ECDC AER 2007 including 2005 data.

Inter-country comparisons of SSI rates should be made with caution because at least part of the inter-country differences can be explained by one or several of following parameters:

1. Differences in post-discharge surveillance methods (e.g. more intensive in the Netherlands and Norway, no post-discharge surveillance in England). The figure also shows an increasing availability of the hospital discharge data in Germany, a figure that is necessary for the identification of post-discharge infections and the calculation of the incidence density.



2. Differences in post-operative length of stay: infections are more likely to be detected while patients are still in the hospital than post-discharge, in the community; the figure below shows large variations in post-operative stay, both within countries as between countries, after hip prosthesis in participating countries; each dot represents one hospital.



3. Selection of hospitals with specific problems in countries with low participation in the SSI surveillance module (e.g. Austria, Belgium);

4. Differences in case-mix and type of operation (although these are partly taken into account by the NNIS risk index), e.g. some countries perform more total hip prostheses and fewer partial hip prostheses (higher intrinsic infection risk) than others within the HPRO category, as shown in the figure below;

5. Different interpretations of the same case definitions, resulting in different percentages of superficial infections being reported;

6. Organisational aspects such as mandatory participation with or without public disclosure of SSI indicators (e.g. in England, http://www.hpa.org.uk/webw/HPAweb&Page&HPAwebAutoListName/Page/1191942150156) may influence the sensitivity of reporting so that changes in rates might not reflect a true change of practices.

Results of HELICS ICU surveillance, 2004-2006

The HELICS-ICU protocol includes a unit-based (level 1, minimal dataset) and a patient-based (level 2) module. In unit-based surveillance, denominator data (patient-days) are collected for the entire unit, in patient-based surveillance, data (including risk factors for risk-adjusted inter-hospital comparisons) are collected for each patient, infected or not. The full protocol is available at http://ipse.univ-lyon1.fr/protocols/icu_protocol.pdf.

Eight patient-based networks (Austria, Belgium, France, Spain, Portugal, Italy, Luxemburg and Lithuania), two piloting countries (Slovakia and Estonia) and one unit-based (Germany) surveillance network contributed data on 7 880 episodes of ICU-acquired pneumonia (PN) and 3 594 episodes of ICU-acquired bloodstream infections (BSI) from 740 ICUs and 583 hospitals in 2006.

Of 51 621 patients staying more than two days in the ICU, 6.8% (mean of ICU cumulative incidences 8.1%, median 6.9%) acquired a pneumonia (intubator-associated 91.2%). The incidence varied from 1.5% in unventilated patients to 22.2% in patients ventilated for one week or more. The median incidence density varied from 3.3 PN episodes per 1 000 patient-days (pd) in ICUs with less than 30% patients intubated, to 6.4 per 1 000 patient-days in ICUs with 30–59% patients intubated and 9.4 per 1 000 patient-days in ICUs with ≥ 60% of patients intubated. Table 3.6.3 shows the distribution of the intubator-associated pneumonia rates by country.

ICU-acquired bloodstream infections (BSI) occurred on average in 3.4% (mean of ICU cumulative incidences 3.4%, median 2.5%) of patients staying more than two days in the ICU. The incidence varied from 1.3% in patients with no intubation to 18.6% in patients who were intubated for two weeks or more. Table 3.2.3.4 shows the distribution of the catheter-associated bloodstream infection rates by country.

Table 3.2.3.4 Distribution of intubator-associated pneumonia rates and catheter-associated bloodstream infection rates in patients staying more than two days in intensive care, by country

	N of patients	N of patient-days	Average length of stay	IUR	CUR	IAP/1000 intubation days	C-BSI/1000 cvc days
Austria	6 602	68 617	10.4	610	854	9.4	2.7
Belgium	3 362	26 687	7.9	415	736	11.3	2.7
Estonia	94	1 274	13.6	852	747	3.7	4.2
France	21 951	243 880	11.1	586	637	13.6	3.7
Italy	1 720	20 041	11.7	556	628	15.1	5.2
Lithuania	1 810	15 159	8.4	404	706	12.7	3.9
Luxembourg	2 144	22 269	10.4	302	624	6.6	2.6
Portugal	795	11 092	14.0	650	811	12.6	3.6
Slovakia	103	1 345	13.1	479	474	20.2	11.0
Spain	13 143	109 785	8.4	469	791	17.3	3.2
TOTAL	51 724	520 149	10.9	532	701	12.2	4.3

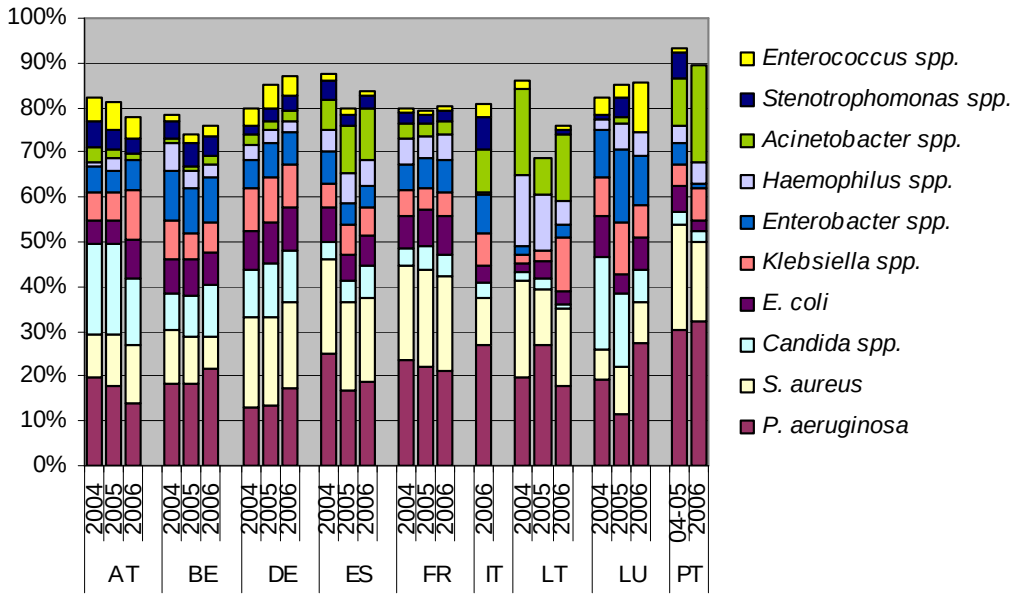
IUR: intubation utilisation rate (N of intubation days x 1000/ N of patient-days).
CUR: central venous catheter (CVC) utilisation rate ((N of central line days x 1000/ N of patient-days).

IAP: intubator-associated pneumonia.
C-BSI: catheter-associated bloodstream infection.
Data from Estonia are pilot data from a single ICU.

Bloodstream infections were catheter-associated (defined as a primary bloodstream infection with central line use in the 48 hours preceding the infection) in 52% of cases. In 35% of the bloodstream infections, the origin was another infection site (pulmonary infection 36%, gastro-intestinal tract infection 21%, urinary tract infection 15%, skin and soft tissue 9%, surgical site infection 7%, other/unknown 11%). Twelve percent of the BSI were primary BSI without association with central line use.

The distribution of the most frequent micro-organisms isolated in ICU-acquired pneumonia and ICU-acquired bloodstream infections are given in Figures 3.2.3.4 and 3.2.3.5.

Figure 3.2.3.4 Evolution of the relative frequency of the 10 most isolated micro-organisms in ICU-acquired pneumonia, 2004–06

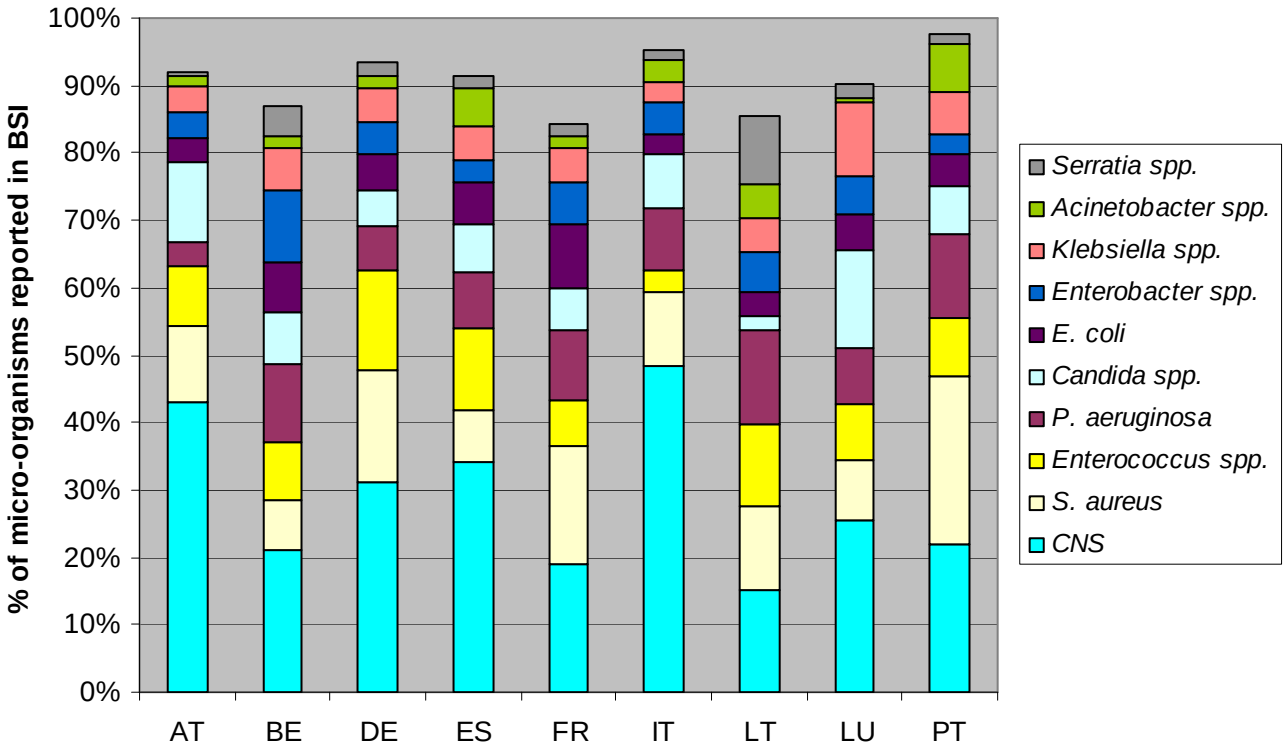


Source: HELICS-ICU.

Overall, the most frequently isolated pathogen in ICU-acquired pneumonia was *Pseudomonas aeruginosa* (19.0%), followed by *S. aureus* (18.0%) with an average percentage methicillin resistance of 42.8%. Inter-country differences showed higher relative frequencies of *Acinetobacter spp*. in Spain, Italy, Portugal and Lithuania, while *Enterobacter spp*. were more prevalent in Belgium and Luxembourg, and enterococci are more frequently reported by Austrian and German ICUs. The percentages of the different micro-organisms remained stable throughout the years.

The most frequently isolated micro-organisms in BSI were coagulase-negative staphylococci, followed by *S. aureus*, enterococci, *P. aeruginosa* and *Candida spp.* (Figure 3.6.10). Again, the percentage of *Acinetobacter spp*. was higher in Spain and Lithuania, while *Enterobacter spp*. were more prevalent in Belgium. The higher proportion of coagulase-negative staphylococci in Italy may indicate more sensitive reporting of skin contaminants in the new Italian network.

Figure 3.2.3.5 Relative frequency of the 10 most isolated micro-organisms in ICU-acquired bloodstream infections, 2004–06

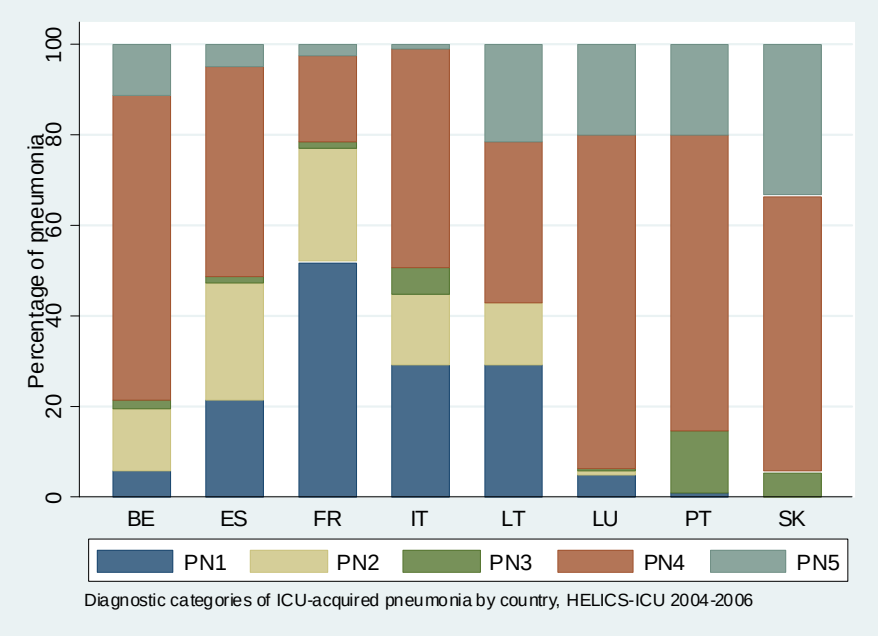


Source: HELICS-ICU. Data for 2004 to 2006 were pooled because of the small numbers for some countries.

CNS=Coagulase-negative staphylococci.

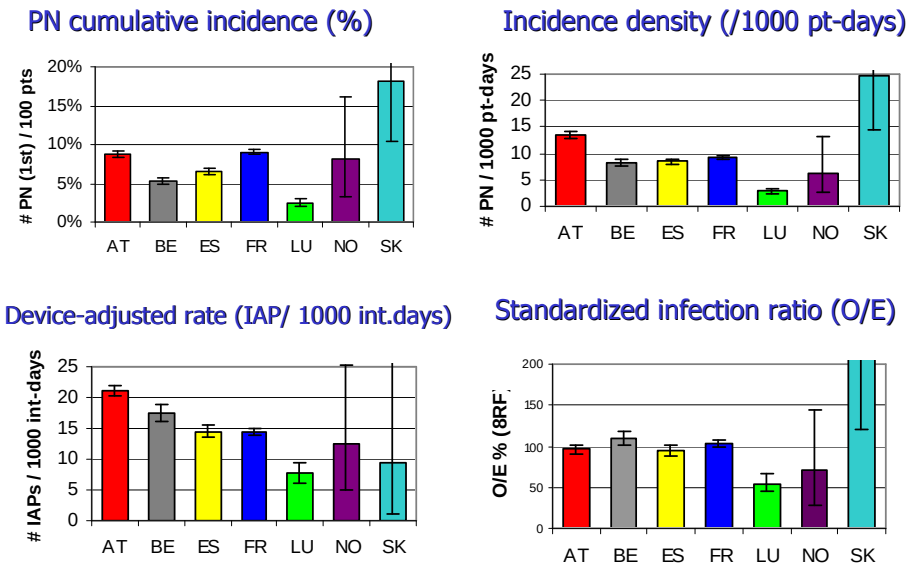
Although the comparability of the ICU surveillance data improved considerably due to increasing compatibility with the common protocol, there are still several remaining issues that should be taken into account when comparing rates of ICU-acquired infections in HELICS:

1. Diagnostic practices of pneumonia differ a lot between countries, a problem that is partially captured by subcategories in the case definitions of ICU-acquired infections; when available, these categories allow for a better interpretation of ICU-acquired pneumonia rates, as illustrated in the figure below



PN1: quantitative culture of invasive sample; PN2: quantitative sample of endotracheal aspirate (ETA); PN3: other microbiological confirmation, e.g. positive blood culture; PN4: qualitative culture of ETA of sputum; PN5: clinical diagnosis only (X-ray+fever 38℃/≥ 12 000 or <4000 WBC/mm^3+dyspnea, purulent sputum, pos. auscultation, worsening gas exchange)

2. A second source of variation of ICU rates are of course the differences in case-mix; these differences are partially taken into account by the calculation of different risk-adjusted indicators, as illustrated by the figure below – countries (and ICUs) will change position in the ranking depending on which indicator is used.



3. Third, in ICU surveillance there are still problems with comparability of data linked to the surveillance protocols, because networks using the US CDC(/NNIS) protocol still have to add some variables or categories to variables in order to be HELICS-compatible; one of the major issues being that patients staying less than 2 days are not included in HELICS, but are included (and cannot be removed) in the denominator of the CDC protocol for the surveillance of ICU-acquired infections.

4. Finally, as with SSI, various differences in case finding methods, interpretation of definitions, or organisational aspects such as public disclosure of rates may have a major impact on

sensitivity of reporting, once again highlighting the absolute necessity to organise EU-wide standardised validation of surveillance of HCAI.

Discussion

The surveillance of HCAI was further extended in 2006, with one additional network joining surgical site infection surveillance (Portugal) and two more patient-based surveillance networks for the surveillance of ICU-acquired infections (Italy and Portugal). Moreover, other countries started piloting in 2006 (Estonia ICU) and the extension process is expected to continue over the coming years.

HCAI infection rates mostly remained stable in 2006, with the exception of a decreasing trend in surgical site infections in hip prosthesis. However, inter-country methodological differences persist and further emphasis should be given to harmonisation of methods, for example through the organisation of a European field validation study to assess the sensitivity and specificity of the different surveillance systems as compared to the case definitions of standardised HELICS protocols. Furthermore, as discussed in the Chapter 2 (healthcare-associated infections), an EU-wide prevalence survey of healthcare-associated infections is needed to assess the burden of all types of infections in Europe. Such a protocol, although less suited than the present protocols for the follow-up of HCAI rates and for risk-adjusted comparisons between hospitals, is likely to promote the surveillance of HCAI because it is simple to implement and would provide useful baseline data.

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3.3 INTRODUCING A NEW SURVEILLANCE TARGET: LONG TERM CARE PATIENTS

3.3.1 Objectives

Health care, previously delivered almost exclusively in acute hospitals, is now delivered through a variety of services, including outpatient and ambulatory care, long-term care, rehabilitative care, and home care. Moreover, the proportion of population >65 years of age is constantly increasing, and the number of patients in long-term care has already surpassed the number of patients in acute care hospitals.

The frequency of Healthcare Acquired Infections (HCAIs) among residents of long-term care facilities (LTC) is comparable to rates observed in acute care facilities, as highlighted by several studies conducted both in the Unites States and in Europe. Table 3.3.1.1 shows some recent epidemiological studies on the frequency of infections in LTC facilities.

Table 3.3.1.1 - Recent prevalence and incidence infection studies in LTC facilities

Author, year, place	Type of study	N°of facilities (n°of residents)	Infection rate
Moro, 2003, Italy	Prevalence	49 (1,926)	9.6 (weighed)
Eriksen, 2004, Norway	Prevalence (4 surveys, 2002-2003)	203-300 (11,465-17,174)	6.6-7.6
Stevenson, 2005, US	Incidence	17 (472,019 resident-days)	3.64
Engelhart, 2005, Germany	Incidence	1 (34,793 resident-days)	6.0
Brusaferro, 2006, Italy	Incidence	4 (21,503 resident-days)	11.8

On the contrary, in the home care setting, available data are scarce, but the occurrence of infections seems to be lower. Between 1 in 10 to 1 in 5 infections in long-term care arise from an epidemic; frequently, healthcare workers are also involved. For the elderly living in these facilities, the onset of an infection represents the most common cause of hospital admission and death**,** mainly from pneumonia. The most common sites of infection are the urinary tract, the respiratory tract, the skin, the gastrointestinal tract and the eye. The endemic infections are above all localised in the respiratory and urinary tracts; epidemic infections are predominantly influenza and gastrointestinal infections.

Residents of long-term care facilities are frequently colonised with antimicrobial-resistant organisms, including methicillin-resistant Staphylococcus aureus, vancomycin-resistant enterococci, penicillin-resistant pneumococci, extended spectrum β-lactamase–producing gram-negative organisms, and quinolone-resistant gram-negative organisms. Several studies have demonstrated that the frequency of antimicrobial resistant infections in these setting is continuously increasing.

Compared to the acute care setting, LTCFs have several features which may hamper the implementation of effective infection and surveillance control programs, such as being increasingly used as step-down units after hospitalisation; being a semi-closed setting, where most elderly residents have their permanent domicile; having fewer resources in personnel, expertise, and diagnostic and support services; and lacking coordinated medical care. Thus, the control of infections represents a challenge in these settings where a number of constraints do exist.

Availability of surveillance data is essential for individual facilities to improve their capacity to control infections and adjust their resources as needed. However, although detailed information regarding the status of infection control and surveillance programmes in long term care in Europe were not available before this project, surveillance of HCAIs in European NHs seemed not to be widespread. Moreover, no agreement existed at the European level regarding preferred methods for the surveillance of infections in this setting as well as the criteria to be used for defining infections.

The main objectives of **IPSE Work Package 7** were:

- To describe the status of infection control and surveillance programmes in long term and home care in Europe, through an ad hoc survey
- To develop a proposal for the surveillance of healthcare acquired infections in long-term care facilities in all the European countries.

3.3.2 Methods

European Survey on Infection Control in Nursing Homes and Home Care Organisation

A questionnaire aimed at describing infection surveillance and control activities was drafted and agreed among the participants of the IPSE WP7 Working Group and the members of the IPSE Project Management Group.

The questionnaire was sent in June 2006 and answers were requested by the end of July 2006. Non respondents were contacted several times, by e-mail, to increase the response rate.

The questionnaire was addressed to the official IPSE National Contact Points. It had to be completed either personally by the National Contact Point or in collaboration with national experts.

Areas of interest of the questionnaire are indicated in Table 3.3.2.1.

Table 3.3.2.1 – Areas of interest of the survey

• **Long term care characteristics:** ✓ National or regional programme ✓ Information system/ad hoc surveys ✓ Accreditation ✓ Type of LTC institutions • **Infection control in LTC and home care:** ✓ Infection control policies ✓ Bodies involved ✓ IC organisation in LTC ✓ Recommendations	• **Infection surveillance in LTC and home care:** ✓ Recommendations ✓ Surveillance system ✓ Studies from 2000 to 2005 ✓ Type of LTC institutions • **Antibiotic and antimicrobial resistance:** ✓ Recommendations ✓ Bodies involved ✓ Antimicrobial use

The following standardised definitions were developed to guide the respondents in completing the questionnaire:

- **Long-term care (LTC)** includes activities undertaken for persons who are not fully capable of self-care on a long-term basis, by informal caregivers, by formal caregivers, professionals and paraprofessionals (health, social and others), or by volunteers. It encompasses a broad array of services delivered in the home and community or in institutional settings.

- **National** means that a single programme is implemented throughout the country.

- **Long-term residential care (LTRC)** means care and accommodation provided as a package by a public agency, non-profit or private company (e.g. nursing homes, residential homes).

- **Long-term care programme** means a plan or policy which defines the LTC services to be provided, the population eligible, and the sources for funding.

- **Long-term care institutions** are places of collective living where care and accommodation are provided as a package by a public agency, non-profit or private company (e.g. nursing homes, residential homes). Long-term care facilities (e.g. long-term care hospitals) providing post-acute care to medically complex patients who need extended medical or rehabilitative care for a limited amount of time are not included for the purpose of this survey.

- **Nursing homes** are facilities designed to offer personal care as well as skilled nursing care to residents.

- **Intermediate care facilities** are facilities which provide health-related care and services to individuals who do not require acute or skilled nursing care, but who, because of their mental or physical condition, require care and services above the level of room and board available only through facility placement.

- **Residential homes** fall between the nursing care delivered in skilled and intermediate care facilities and the assistance provided through social services. It can be broadly defined as the provision of 24-hour supervision of individuals who, because of old age or impairments, necessarily need assistance with the activities of daily living.

- **Home care (HC)** includes a wide range of health-related services such as assistance with medications, wound care, intravenous (IV) therapy, and help with basic needs such as bathing, dressing, mobility, etc., which are delivered at a person's home.

- **Routine information system** is a system where information is derived at regular intervals of a year or less through mechanisms designed to meet predictable information needs.

- **Resource Utilization Group (RUGIII)** is a case-mix classification system of patients in nursing facilities by disability and other care needs.

- **Accreditation programme** is a process whereby LTC institutions are recognised by an external body as meeting predetermined standards.

- **Infection control programme** in Long-term care and/or home care is a programme aimed at controlling infections acquired during long-term care, through surveillance and/or adoption of evidence-based infection control policies and procedures.

Data were entered into a database in Access and analysed by the SPSS 9 statistical package.

Proposal for the surveillance of nursing homes acquired infections in Europe

Taking into account the results of the European Survey on Infection Control in Nursing Homes and Home Care Organisation (i..e. the diffusion of infection surveillance activities in LTC facilities in Europe, the type of residents accommodated in different countries, and the resources available), a proposal for the surveillance of HCAIs in LTC facilities in Europe was drafted and discussed among participants to the WP7.

The proposal includes:

- An agreed protocol for conducting prevalence surveys at country or local level.
- A recommendation to include nursing homes in outbreak and alert system surveillance.
- A recommendation to conduct audit programmes in nursing homes taking advantage of existing tools.
- A recommendation to use, whenever possible, existing laboratory and pharmacy information systems, to monitor antimicrobial resistance and antimicrobial use.

An advanced draft, taking into account suggestions and comments, was re-written and circulated again among WP7 participants.

3.3.3 Main achievements

European Survey on Infection Control in Nursing Homes and Home Care Organisation

Out of 33 questionnaires, 26 were returned (78.8%). The seven missing countries were Cyprus, Greece, Malta, Poland, Romania, Slovenia and UK-Northern Ireland. UK-Northern Ireland sent information about the general organisation of infection control activities in the long-term care setting. A complete questionnaire was returned from Austria, Belgium, Bulgaria, Croatia, The Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania, Luxembourg, The Netherlands, Norway, Portugal, Republic of Ireland, Slovakia, Spain, Sweden, Turkey, UK- England, UK- Scotland, UK-Wales.

The most important issues highlighted by the survey are discussed below.

1. ***The true identity of long term care services across the respondent European countries is frequently unknown.***

The survey clearly showed that in several European countries, programmes aimed at the governance of long-term care facilities, through the definition of general rules, the implementation of an information system, and of an accreditation program, do not exist.

Less than half of the surveyed countries claimed to have a national plan or policy defining the services to be provided, the population eligible, the sources for funding, both for long term care facilities and home care (Table 3.3.3.1). Only one third of the surveyed countries claimed to have a national information system, with available data, for long-term care and fewer for home care. Only one third claimed to have implemented an accreditation system for long term care and even fewer countries claimed to have such a system for home care.

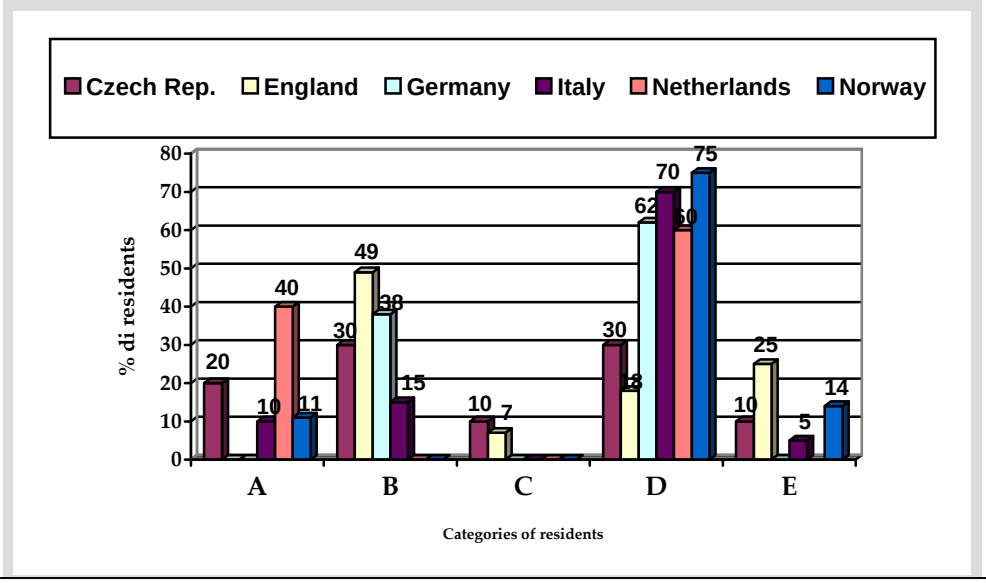
Table 3.3.3.1 - National programmes for long-term and home care

National programmes	**LTC**	**HC**
	n (% of respondents) [% of the 33 targeted countries]	n (% of respondents) [% of the 33 targeted countries]
Does a national programme exist?	16 (61) [48]	13 (50) [39]
Is national data available on the number and characteristics of facilities/programmes?	11 (42) [33]	8 (31) [24]
Does a national system exist for the accreditation of facilities/programmes?	11 (42) [33]	7 (27) [21]

2. ***A significant variability among countries of residents and type of organisation exists***

Figure 3.3.3.1 shows the distribution of residents, by five different categories of care need, within facilities described as “nursing homes” in different European countries: the proportions of residents belonging to each category is highly variable in the respondent countries.

Figure 3.3.3.1 - Type of residents in "nursing home-like" facilities across European countries



A= Rehabilitation B = Custodial/supportive care C = Mental disorders D = Medical/nursing care E=Dementia

No uniform system exists aimed at classifying residents according to their conditions and need. The Katz scale, or an adaptation of it, is used in Belgium, and in Portugal. All the other countries used different scales (Table 3.3.3.2).

Table 3.3.3.2 - Systems used to classify residents according to their conditions and needs

Country	Long term residential care	Home care
Belgium	An adaptation of the Katz-scale is used to classify care needs in 5 categories (O, A, B, C, CD-category) which determines the financial intervention (fixed rate) provided by the national insurance system.	
France	AGGIR score	Karnofsky score
Germany	Pflegestufe I-III	Pflegestufe I-III
Lithuania	Classification of need	Classification of need
Netherlands	Not used yet, will most probably start in 2008.	
Norway	Information on most aspect of care needs is reported at local levels, but such information is not widely available on a national level.	Care needs reported at local levels, but such information is not widely available on a national level.
Portugal	KATZ Index; Mini Mental State	
Republic of Ireland	Long stay activity statistics were collated nationally on 31/12/05 for all older person services. Residential Public + Private submission to the Department of Health.	
Wales	Categorised as elderly nursing/dementia, residential or nursing.	Broadly categorised as to care requirements.

3. The perception of the relevance and the resources available for infection control are scarce

Despite the significant burden of infections in long-term care, very few European countries claimed to have developed policies aimed at reducing the risk of infection transmission in these settings (Table 3.3.3.3). The most frequent activity in infection control in the long term care setting is represented by the definition of guidelines; however, only less than half of the 33 surveyed countries reported at least

one infection control guideline, developed specifically for long-term residential care, and one third for home care. The most frequently issued guidelines are general recommendations, and those related to outbreak control, isolation measures, hand hygiene, immunisation of residents, and disinfection/sterilisation.

The organisation of infection control and surveillance activity reflects the scarcity of resources available: in only 5 countries, an ICN is available within the long term residential facilities, in all cases, except one, on a part-time basis; consultancy by the hospital infection control nurse is provided in eight countries for long term residential care and 6 for home care. Only five countries claimed that an educational programme related to infection control exists in the long term care setting.

Table 3.3.3.3 - Infection control guidance and activities in Long-term and Home care

National programmes	**LTC** *n (% of respondents) [% of the 33 targeted countries]*	**HC** *n (% of respondents) [% of the 33 targeted countries]*
Is there a national law on infection control in these services?	8 (31) [24]	7 (27) [21]
Is infection control included in the national criteria for: o the authorization of these services? o the accreditation of these services?	 4 (15) [12] 7 (27) [21]	 3 4 (15) [12]
Are there national recommendations or guidelines on infection control in these services?	13 (50) [39]	7 (27) [21]
Is there a legally responsible person for infection control in these setting?	12 (46) [36]	11 (42) [33]
Is there an infection control nurse within the service?	5 (19) [15]	3 (12) [9]
Is there consultancy by the hospital infection control nurse?	8 (31) [24]	6 (23) [18]
Is there an infection control committee responsible also for infection control policies?	6 (23) [18]	4 (15) [12]
Is there an education programme on infection control involving LTC personnel?	5 (19) [15]	5 (19) [15]

4. Few epidemiological data on infections are available at the European level

Only five countries reported having conducted studies in the period January 2001-December 2005, at national, regional or local level, aimed at measuring the frequency of infection in long-term care (Table 3.3.3.4).

Table 3.3.3.4 – Epidemiological studies on frequency of infections in long term care facilities, 2001-2005

Country	Year	Type of study	Number of			Key results
			F[§]	B	P	
Belgium	2005	National prevalence of MRSA infections	60	6365	2958	- MRSA-prevalence = 19% [CI95% 17-22] - Resistance proportion = 38% [CI 95% 33-42] - S. aureus prevalence = 51% - Risk factors: high GP/bed ratio in NH with low MRSA control index, previous hospitalisation or AB-use, current known MRSA-carriage, impaired mobility, presence of wounds, care need category 'O', absence of therapeutic formulary
France	2001	National prevalence, all infections, all healthcare facilities including LTCF	283	32335	28164	Prevalence= 9.5%
	2005	Regional prevalence, all infections, LTCF only				Prevalence=14.5%
	2007	National prevalence, all infections, LTCF only	224		16570	Prevalence=9.34%
Germany	2000	Local prevalence, MRSA	31		1342	prevalence 2.4% MRSA
	2001	"	1	35		1. prevalence 21%; 2. prevalence 26% and analysis of risk factors for MRSA colonisation
	2002	Regional prevalence of MRSA	61		1057	Analysis of risk factors for MRSA colonisation Prevalence MRSA 3%
	2002	Local prevalence of MRSA	27		49	Identifications of MRSA colonised residents and development of specific procedures in each home
	2003	"	30			survey on MRSA in nursing homes and homes for the elderly; management of MRSA
	2005	Local incidence of all infections	1	103		Incidence rate 6/1000 resident days
Italy	2001	Regional prevalence of all infections	49		1926	LTCF-prevalence 14.6/100 in NH and 7.5 in RH
	2003	Local incidence of all infections	4		859	LTCF-incidence 11.8/1000 person-days
Norway	2002	National prevalence UTI,	202/323		15690/17174	prevalence 6.6 (6.2-7.0); 7,3 (6,9-7,7)
	2003	LRTI, SSI, skin infection			13444/11465	prevalence 6.9 (6.5-7.3) ; 7.6 (7.1-8.1)
	2004		414/252		20058/12836	prev 7.1 (6.7-7.4); /6.8 (6.4-7.2);
	2005		114/285		7555/14901	prev 6.3; 7.0 (6.6-7.4);
	2006		287		14849	prev 7.1 (6.7-7.5)

§ F=number of facilities; B=number of beds; P= number of persons

Five countries (Germany, Lithuania, Norway, Portugal and Sweden) declared having issued recommendations for the surveillance of infections in long-term care residential care, all in recent years (median 2004, range 2003-2007), and two for home care in 2004 and 2007, respectively. The two countries which have issued recommendations for surveillance in home care are Portugal (in 2007) and Sweden (in 2004): in both cases explicit criteria for infection definition have not been defined, continuous surveillance is recommended and, in the case of Sweden, surveillance is compulsory.

Five countries claimed to have set up a surveillance system for infections in long term care residential facilities and two for home care (Table 3.3.3.5).

Table 3.3.3.5 – Surveillance system in long term care residential care and home care

	LTRC N°of countries	HC N°of countries
Surveillance system	5	2
National	3	2
Managed by		
the Ministry of Health	1	1
a Public Agency	4	1
Methods used		
Periodic prevalence	4	2
Continuous surveillance	1	-
Antimicrobial resistance data	2	1

5. Antibiotic and antimicrobial resistance policies have been set up in few European countries only

Despite the challenge of antimicrobial resistant microorganisms selection in LTC, only 12 countries declared having issued at least one recommendation for antibiotic and antimicrobial resistance control in long-term care. Nine countries have issued recommendations in home care, ranging from 1 to 6 recommendations (Table 3.3.3.6).

Table 3.3.3.6 – Recommendations for antibiotic and antimicrobial resistance control in long term residential care and home care

	LTRC N°of countries (years range)	HC N°of countries (year s range)
General recommendations	8 (1975-2006)	6 (1975-2000)
Prevention of Multidrug Resistant Organisms	6 (1999-2004)	5 (1999-2004)
MRSA	10 (2004-2006)	7 (2004-2006)
VRE	4 (2005)	2 (2005)
ESBL	3 (2005)	1
Antimicrobial resistance surveillance	1	1

Data on antimicrobial use in long-term residential care on a national basis are not available: one country declared having this system in place but details were not provided. In all the other cases, information is available at local level or at national level but it is not possible to simply identify residents of LTC facilities.

In only three countries, a limited list of antimicrobials can be prescribed in LTRC.

Proposal for the surveillance of nursing home acquired infections in Europe

While preparing the proposal of a European minimum protocol for the surveillance of infection in this setting, it was agreed to take into account the following:

- It is necessary to increase the awareness, of both health managers and healthcare professionals, of the consequences of infections in LTC, by spreading information on the few epidemiological studies conducted in European countries and experiences in place, throughout all Europe.
- While continuous surveillance of infection within each facility should be strongly encouraged in order to identify infected patients and prevent potential epidemics in a timely way, data collection of national or regional infection rates is probably better achieved through periodic prevalence surveys, due to the scarcity of infection control staff available in this setting.
- Some countries have developed audit tools for LTC, which can be very useful to promote compliance with recommended care practices.
- Information systems on antimicrobial consumption, able to analyse utilisation of these drugs in LTRC, need to be urgently developed.

Based on these assumptions, a proposal for infection surveillance in long-term care residential facilities was developed taking into account the following two issues:

1. Valid data on infection are essential for:
   - individual facilities to improve their capacity to control infections and adjust their resources as needed.
   - convincing nursing home administrators and regulatory agencies that infection control in LTCFs is important and worthy of support and more resources are necessary to improve the quality of care and the safety of residents.
2. Available resources for surveillance in European LTC facilities are scarce:
   - routine data should be used whenever possible (e.g laboratory data)
   - simple data and surveillance methods should be preferred

The proposal includes:

- a protocol for carrying out prevalence surveys of healthcare infections in LTCFs with a standardised approach, based on a minimum set of data;
- the description of additional tools and methods which have been adopted in selected European countries for specific events in nursing homes (i.e. surveillance of outbreaks or audit programmes of selected care practices);
- a recommendation for making possible the use of routine information sources (laboratory and pharmacy database) to collect information on antimicrobial resistant microorganisms and antimicrobial use.

3.3.4 Future perspectives

The general picture which emerges from the European wide survey is worrisome. Despite the emerging threat of healthcare acquired infections outside of the hospital, very few European countries had given sufficient attention to the issue of infections acquired in the long term care setting. Resources available for infection control are sparse as well as experiences of national infection surveillance systems, both in long term residential care and home care.

Surveillance has been demonstrated by several authors to be an important component of effective infection control programs in long-term care. In the last decades, both in United States and Canada, resources have been specifically assigned to infection surveillance and control in long-term care and several studies have documented the achieved transition from surveillance systems based on prevalence surveys to continuous surveillance.

Nowadays in Europe, recommending continuous surveillance appears to be impossible due to resource constraints and lack of perception of the relevance of infection control efforts in LTC, involving both LTC facilities managers as well as health care workers in these institutions.

As a consequence, the future development of a project aimed at promoting the surveillance of infection in long term care facilities in Europe should include the following:

1. Prevalence surveys in long-term care

- a **European wide prevalence survey** in long-term care facilities would be useful in an initial phase to: a) measure the overall prevalence and the prevalence of specific infection in elderly residents of nursing and residential homes; b) to increase education and awareness of NH-healthcare workers, NH-managers, and national, and regional institutions concerning the public health relevance of infection control in LTCFs; c) to contribute to the implementation of infection control programmes in long-term care facilities and to encourage and help European countries to face the tremendous challenge of safe care for a rapidly increasing ageing population with high skilled care needs.
- Additionally to the European wide prevalence survey, the **LTCFs should be encouraged to carry out prevalence surveys at local level** using the standardised proposed protocol.
- Additional research is needed concerning the **minimum set of variables** to be collected in prevalence surveys, in order to be able of meaningfully interpreting the results.

2. Additional activities

- Accurate and reproducible infection definition criteria are necessary for implementing an effective infection surveillance system. The definition proposed by McGeer needs to be evaluated in the European context: thus a **project should be planned which aims at evaluating the accuracy and reproducibility of McGeer infection definition criteria** in different European LTCFs.
- It is advisable **to develop and validate a screening tool to collect data concerning signs and symptoms of infections,** to be used daily by nursing home care personnel. It should allow even those staff members who are not highly trained staff to collect pertinent data suggestive for infection, based on signs and symptoms being associated with different degrees of infection probability.
- **National outbreak surveillance systems, also involving LTCFs, should be encouraged** in order to be aware of outbreaks of HAI and their presumed aetiology as rapidly as possible after their identification, to collect a standard national minimum dataset on HAI outbreaks after their investigation is complete to enable an estimation of trends in the number of outbreaks over time and in different locations, and to provide an overview of the characteristics of outbreaks nationally in terms of aetiology, size, and severity.
- **Audit programmes of selected healthcare practices** in LTCFs should be encouraged, with the aim of improving compliance with standards for infection control, monitoring practice against those standards, feeding back findings to nursing homes, re-auditing practice, and making final observations.

- **Information systems on antimicrobial consumption**, able to analyse utilisation of these drugs in LTRC, need to be urgently developed.
- Research should be focused to identify which conditions (resources, training, simplified data collection) need to be satisfied in order to make possible the **continuous surveillance of infections in nursing homes**.

3.3 Enhancing Event Warning and Rapid Exchange

3.3.1 Introduction

Outbreaks of healthcare-associated infections are probably amongst the most under-reported reportable conditions in the area of infectious diseases. The connotation of guilt of the institution and care providers which almost always accompanies such an event, even when it was not clearly preventable, makes this kind of information extremely media-sensitive with potential important economic and legal consequences if the information is disclosed to the public. Problems are usually dealt with internally by the hospital infection control staff without involving public health officials or epidemiologists from public health institutes. The latter also often lack the capacity – in terms of resources, skills, or both – to offer substantial aid to the institution in controlling an outbreak.

Apart from the targeted surveillance networks, specific systems to report unusual nosocomial events are rarely in place in Member States. Some MS have nosocomial epidemics or unusual infections generically or specifically defined in their list of mandatory reportable diseases, while in other countries, such as several eastern MS, all nosocomial infections are mandatory reportable, which with the high number of nosocomial infections occurring under baseline conditions inevitably leads to severe underreporting and dilution of unusual events. In July 2001, France however published a Decree obliging healthcare institutions to report nosocomial infections according to pre-defined criteria (Décret n° 2 001-671 relatif au signalement des infections nosocomiales, http://www.sante.gouv.fr/htm/pointsur/nosoco/circul.pdf): infections with rare pathogens, infections with pathogens with an unusual resistance profile, infections that are a threat to the patient's survival or lead to important functional sequellae, infections related to the use of contaminated medical devices, and epidemics or clusters with a risk of spread. Although these criteria still encompass a lot of "noise", e.g. many "endemic" nosocomial infections - such as ventilator-associated pneumonia in ICU patients - are potentially fatal and often non-preventable, this system has considerably enhanced the detection of relevant nosocomial threats in France including events with an international dimension[4].

3.3.2 Objectives

The objective of **IPSE Work Package 3** was to develop, in conjunction with EARSS, a standardised internet-based Nosocomial Event Warning System (NEWS) that can be implemented at the national/regional level. This system should provide national/regional professionals with a tool to collect timely information and allow them to respond adequately to threats regarding infectious diseases and control in hospitals and facilitate the information exchange with the EU-DG SANCO level (EWRS). In addition, the centralisation of nosocomial events at the EU-level (RIVM/EARSS-IBIS) may identify cross-border dynamics that would remain undetected at the national level.

The Internet-based information system was made available to all hospitals and interested parties. In any case, events submitted to the system will first be treated as confidential by the national and only be further transmitted after validation.

[4] Signalements externes des infections nosocomiales, France, 2006. Bull Epidemiol Hebd 2008;(30-31):265-8. http://www.invs.sante.fr/beh/2008/30_31/index.htm

3.3.3 Methods

A working group on early warning for nosocomial events in collaboration with EARSS was constituted. Minimal content, information flow, validation procedures, and interactions with the EWRS system were defined on meetings held on 14/3/2005 and 4/4/2005. A propotype was developed and sent out to the IPSE network members for comments in May 2005. The internet-based tool was developed as an integrated part of the EARSS-ibis tool, and sharing functionalities with the latter. Several meetings were held at RIVM Bilthoven with representatives from IPH Brussels (IPSE), RIVM (EARSS) and the IT team responsible for the development. Priotities for development within the available budget as well as work progress were discussed at these meetings.

The use of the infomation system was promoted during the annual network meetings of IPSE. Some countries launched the use of the system during national conferences.

3.3.4 Main achievements

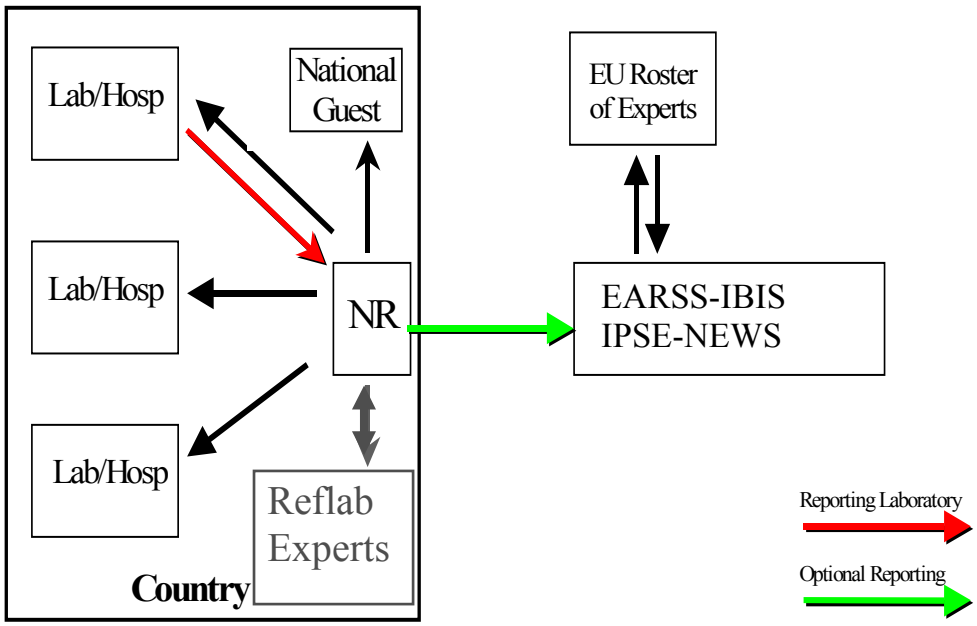
A nosocomial infection warning system (IPSE-*NEWS*) was built on the basis of an existing template that was created for the rapid communication aiming the participants in the European Antimicrobial Resistance Surveillance System (EARSS-*ibis*). The system was made available for reporting to hospitals participating to the national surveillance networks of nosocomial infections or any other healthcare institutions as requested by the national representatives.

Main characteristics of the system

Management and validation of the information at the national level

Although the database is located on a central server (EARSS, RIVM, Bilthoven, NL), the information entered in the IBIS/NEWS system is managed at the national level. All national networks function fully independent of each other. Reports submitted and released among participants within one national EARSS-*IBIS*/IPSE-*NEWS* network are confidential and *remain invisible* to the central EARSS (or IPSE)-Management Team and to the participants of other national networks outside the reporting country, unless released to the entire European audience by the national IBIS and/or NEWS representative (NR). The national representative, supported by a panel of national experts covering the pathogens and events for which reports can be expected, first verifies the information with the reporting hospital/laboratory (figure 3.3.4.1).

Figure 3.3.4.1. Information flow in the EARSS-*IBIS*/IPSE-*NEWS* system



After validation of the reported event, the NR may decide to release the information to inform the national network or the international network of IPSE-NEWS, IBIS-EARSS or both, or to inform the local public health authorities (option only available for IPSE-NEWS, not for EARSS-IBIS). He or she will also discuss the event with the competent national authority and examine the criteria for reporting the event to the EWRS system of DG Sanco.

User levels, management of user information and multilingual feature

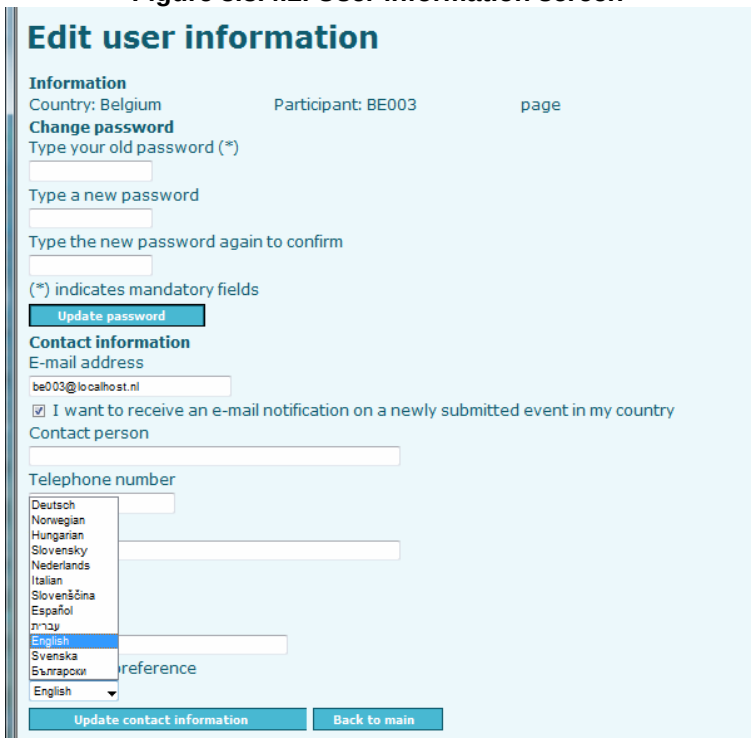
The user levels and their corresponding rights are summarized in table 3.3.4.1. Events can either be submitted by a healthcare institution who has been given a password and a username, or by the national representative (NR). The status of an event, i.e.

Table 3.3.4.1. User levels and corresponding functions in the IBIS/NEWS system

	Hospital/ participant	National representative	National Guest	NEWS coordinator
Submit an event (infection/cluster)	x	x		
Edit an (my) event	x	x		
Delete an (my) event	x	x		x
Change status of an event		x		
See list of events	x	x	x	x
Edit user info, set language	x			
Set mail preferences	x			
Receive alert e-mails	x	x	x	x
Submit to national network		x		
Submit to national guests		x		
Submit to NEWS coordinator		x		
Submit to international network(s) when allowed by NR				x

Because the system is to be used by healthcare institutions, the system has been translated (12 languages until now, see figure 3.3.4.2.).

Figure 3.3.4.2. User information screen



Mandatory and optional fields

The information collected in the nosocomial event screen can be categorised in structured information (figure 3.3.4.3) and free text (but mandatory) information (figure 3.3.4.4). Structured fields use categories or code lists from the HELICS surveillance protocols were available (e.g. ward type list, micro-organism list).

Figure 3.3.4.3 Information collected in structured information

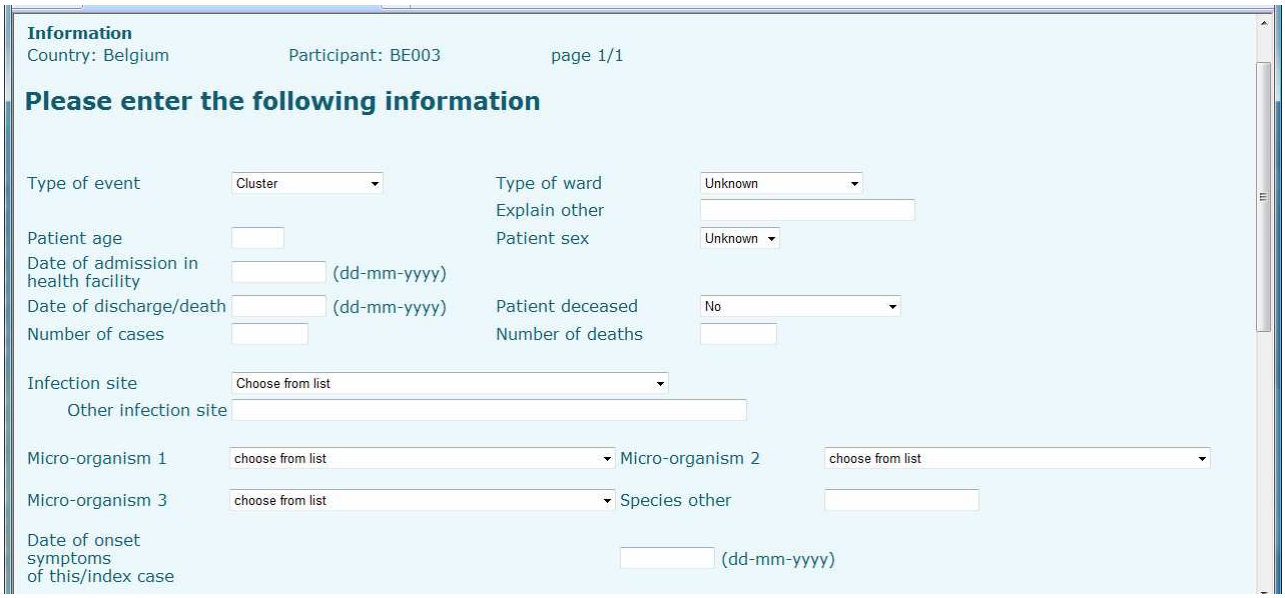
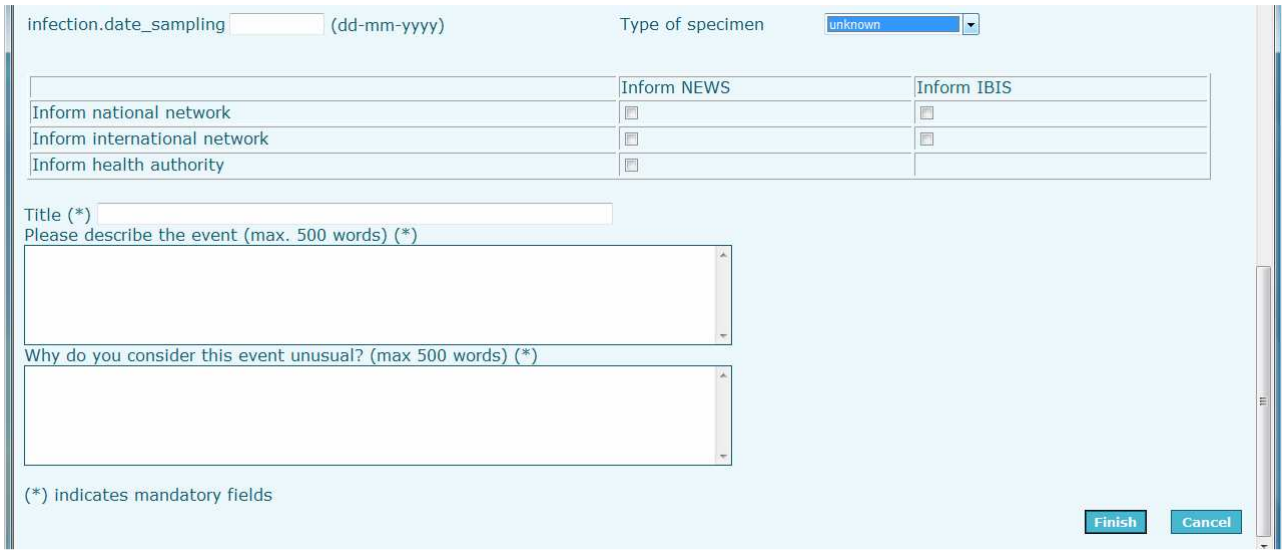


Figure 3.3.4.4 Information collected in free text



In order to keep the threshold for reporting as low as possible, only the title, a short description of the event and a comment concerning why the event is considered as unusual, were kept mandatory.

Use of the system and limitations

Although some information (test cases) were entered by some national representatives and the system has been proposed or even launched in some countries, no events were reported by the healthcare institutions. The proposed events for reporting in the pilot phase were the following:

1. Unusual nosocomial infections:
    - *P. aeruginosa*, carbapenemase +
    - *A. baumanii*, BLSE + and/or carbapenem-R
    - VISA – VRSA
    - VRE
    - Community-acquired MRSA
2. Healthcare-associated nosocomial epidemics
    - *C. difficile*
    - Scabies epidemics
3. Other nosocomial events: product alerts and infections related to contaminated medical devices

This list may however not have the same relevance in all countries and may have to be adapted locally. For instance, in some countries with a high prevalence of carbapenem resistance in *Pseudomonas aeruginosa* or *Acinetobacter baumannii* , colistin resistance may be a more appropriate marker to trigger specific interventions, while in other countries some of these markers may be too rare.

Several reasons may be responsible for the lack of reporting. First, as mentioned above, nosocomial epidemics or unusual events are highly sensitive information and generally healthcare institutions rather keep such events behind closed doors. Second, during the NEWS network meetings, the issue of data security of the current IBIS/NEWS system was challenged. It is indeed not technically excluded that the information submitted to the system could be hacked by mala fide persons, which is given the media-sensitivity of this type of information, not acceptable. This fact certainly influenced the interest of the countries to participate in the pilot. Third, the system could probably have been more promoted among the hospitals in the countries, but resources available for this were limited. Fourth, the ECDC evaluation of both EARSS and IPSE concluded that the IBIS/NEWS system should be integrated (in practice: re-developed) in the EPIS (EPidemic Intelligence System) of ECDC, which indeed is the most appropriate institute to host, coordinate and animate such a system.

3.3.5. Future perspectives

Following the recommendations of the ECDC evaluations of EARSS and IPSE carried out in 2006 and 2007, and given the urgent transition of IPSE to ECDC after the end of the project in June 2008, it was decided in June 2008 that:

1) ECDC (Preparedness and Response Unit) will develop a tool for national representatives only within EPIS at this stage. The characteristics of this system are listed below.

- similar platform for all disease-specific programmes of ECDC
- the platform is structured as a discussion forum with new topics or categories being created dynamically as needed
- the discussion forum will be coordinated and animated by ECDC (Preparedness and Response Unit in collaboration with the disease-specific program staff in the other units)
- the access to the system will be limited to the AMR and HCAI national contact points only in a first stage; access with different levels of rights may be extended to other participants such as reference laboratories or (reference?) hospitals, according to what the network decides
- the EPIS system will be launched by ECDC in spring 2009

2) ECDC will carry out a feasibility study in order to

- assess the degree to which member states really want a structured system like the current EARSS-IBIS/IPSE-NEWS web application allowing them to capture information on unusual AMR bacteria and nosocomial epidemics from the (peripheral) laboratories and hospitals, i.e. a central web application hosted at ECDC with signal analysis by the national contact point or delegate and "release" of the information by the NCP to the EU level (ECDC) after validation
- assess whether the forms developed by the (EARSS and) IPSE project(s) are appropriate or should be modified;

In light of these recommendations and decisions, it was judged unnecessary to further promote the use of the current system located at RIVM in order not to interfere with the new system being located at ECDC. The developed prototype however remains very valuable in light of this future development.

4.0 Dealing with Antibiotic Resistance in European ICUs

4.1 Context and Background

ICU acquired infections, which are often caused by antibiotic resistant bacteria, pose a threat to patients admitted to European ICUs (1-10). Invasive procedures, high antibiotic usage and transmission of bacteria between patients due to inadequate infection control procedures may explain why ICUs are "hot zones" for the emergence and spread of microbial resistance (1,4,6). There is a clear need for surveillance and early warning systems that can pick up signs of emerging and/or increasing microbial resistance at the local, regional and national level (11). A further use of a similar system could be to support local audit and benchmarking of microbial resistance and antibiotic use. A prototype programme was developed and used for regular audit of antibiotic use, microbial resistance to antibiotics and infection control procedures in Swedish ICUs. A central component was a web-based application (http://www4.smittskyddsinstitutet.se/careicu) which included a system for automatic feed-back (7). In **IPSE Work Package 5**, the programme was revised and adapted to suit other EU Member States. It was launched under the name of Controlling Antibiotic Resistance in ICU (Care ICU, 12).

The overall aim of Care-ICU is to hold back the emergence of microbial resistance by judicious use of antibiotics and to establish interventions in infection control and antibiotic policy tailored to the needs of each participating ICU. It is our experience that clinicians often lack data on patterns of microbial resistance and antibiotic consumption within their own ICU and hospital. The first important step to amend this is to improve surveillance and provide rapid feedback of microbial resistance, antibiotic consumption and use of hygiene precautions. Therefore, national ICU-networks and individual ICUs were invited to participate in Care-ICU. ICUs from eight countries took part in the first phase of the programme.

IPSE Work Package 6 dealt with the emergence and spread of antimicrobial resistance (AMR) in bacterial species which has increased the burden of healthcare-associated infections. Within healthcare facilities, the unique nature of the intensive care unit (ICU) environment makes it a focus for the emergence and spread of many resistant pathogens. ICU-patients are frequently treated with broad-spectrum antibiotics, and the ICU presents various risks for the cross-transmission of resistant bacteria from patient to patient. As a result, rates of colonisation and infection with resistant pathogens are almost always higher among patients in the ICU than in other healthcare settings.

4.2 Controlling Antibiotic Resistance in ICUs

4.2.1. Objectives

1. Implementation of a web-based program, developed by ICU-STRAMA http://www4.smittskyddsinstitutet.se/IvaStrama/resist.jsp, for the coordinated collection of information on ICU-structure, IC-practices, AB-policies, AB-use, AB-resistance (AB-R), in participating ICUs.

2. Understanding the value systems that govern decisions of antimicrobial therapy in the ICUs in different countries in the European Union and Candidate Countries.

3. Reviewing guidelines for antibiotic use and IC for prevention of AB-R in the ICUs.

4. Establishing best practice as regards to AB-policy and hygiene interventions which may vary between and within ICUs and will certainly vary over time, but as this is a long-term project, it will allow continuous revision in the struggle to control AB-R.

5. More appropriate use of AB and improved quality of hospital hygiene leading to decreased occurrence of AB-R bacteria in ICUs.

4.2.2 Methods

This is a descriptive study of the first results of the Care-ICU programme. National ICU-networks and individual ICUs were invited to participate in the web-based data collection. Initially, the participation of a small number of ICUs was sought in each of the countries participating in the IPSE project. The national contact points of IPSE were asked to identify ICUs that would be willing to take part in the large pilot study. Thirty-five ICUs from eight European countries (Croatia 4, Czech republic 3, Estonia 3, Hungary 8, Malta 3, Romania 1, Sweden 10, Turkey 3) participated. One neonatal ICU in Malta contributed with microbial resistance data only, since there is no standard in the WHO DDD system for antibiotic use in neonates. There were 21 ICUs in university hospitals and 14 ICUs in general hospitals (13 teaching, 1 non-teaching).

Data on antibiotic use, microbial resistance and infection control procedures were collected according to the Care-ICU protocol (http://www4.smittskyddsinstitutet.se/careicu accessed 2008/06/16). Following submission of data from the local ICU the national administrator, who was a physician, validated data entries and clarified unexpected entries with the primary site. The project leaders, who performed the aggregation and statistical analyses of the data, identified outliers and notified national administrators for further validation and explanation. Final aggregation and analysis was performed.

Antibiotic consumption

Data on antibiotic consumption based on the Anatomical Therapeutic Chemical (ATC) classification system were collected and entered into the database using the web application. Antibiotic consumption was expressed as Defined Daily Doses (DDD) per 1 000 occupied bed days (DDD_{1000}). We used the annually updated DDD calculated by the WHO Collaborating Centre for Drug Statistics Methodology as the average maintenance dose per day in adults for the main indication of the drug (http://www.whocc.no/atcddd , accessed 2008/06/16). Calculation of DDD was made easier with an Internet-based "ABC Calc" tool (http://www.escmid.org/esgap, "Scientific issues").

Bacterial isolates, susceptibility testing and breakpoints

Samples were taken on clinical indication and cultured and tested at the local microbiology laboratory. Repeat isolates were excluded and only initial isolates were considered. It was not determined if the isolates represented ICU-acquired infections, community acquired infections or only colonisation of the patients. Data on distribution of species were entered for all isolates including blood

isolates. Susceptibility testing was performed at the time of sampling using standardised methods, following national guidelines. Microbial resistance was defined as the proportion of strains showing either intermediate susceptibility or resistance. E. coli and K. pneumoniae isolates with decreased susceptibility to cefotaxime and/or ceftazidime were defined as extended spectrum beta-lactamase (ESBL) phenotypes. The extent of multidrug resistance among P. aeruginosa was characterized by the number of antibiotics among aminoglycoside, ceftazidime, ciprofloxacin and carbapenem to which > 90% of isolates of a species were susceptible. These antibiotics were defined as treatment alternatives (TA_{90}) which is a novel index of susceptibility (13).

The density of resistance

We calculated the density, or burden of resistance, defined as number of resistant isolates/1000 admission days. This index makes it possible to gauge the risk for the individual patient to acquire a resistant pathogen.

Questionnaire on ICU characteristics and infection control

Participating ICUs were asked to provide data on length of stay, number of admissions, severity of illness scores, standard working procedures for hygiene precautions and antibiotic treatment guidelines. Information was also gathered about how often feedback about antibiotic consumption was given by the local pharmacy, and how often feedback about local resistance patterns was given by the hospital microbiology laboratory.

Statistics

Correlations between antibiotic consumption and resistance rates or burden were analysed with the Spearman rank correlation using SPSS version 15. To reduce the effect of mass significance, statistical significance was assumed if $P < 0.01$.

4.2.3 Main achievements

Thirty-five ICUs from eight European countries participated in the collection of data for 2005. The response rate of different items in the protocol varied from 100 % (i.e. microbiology) to 26 % (consumption of disinfectant in the infection control part of the questionnaire). The median annual number of admissions to ICU was 551 and the median summated length of stay per ICU was 2,595 days.

ICU characteristics and infection control

Bedside facilities for hand disinfection were generally available. Routines for screening for alert microorganisms, presence of isolation precautions and cohort care for patients colonised or infected with alert organisms are shown together with some selected stewardship measures in Table 1 and Figure 1.

Antibiotic consumption

Antibiotic consumption varied widely, ranging between 348 and 4 992 DDD_{1000} with a median of 1 254 DDD_{1000}. DDD_{1000} split by major antibiotic classes is shown in Figure 2.

Microbial resistance

Thirty five ICUs contributed data on microbial resistance. The frequencies of microbial resistance among Staphylococcus aureus, E. coli, A. baumannii, E. cloacae, P. aeruginosa and K. pneumoniae for all participating ICUs in each country are shown in Table 2.The pattern of microbial resistance varied greatly between species, ICUs and countries (Tables 2 and 3, Figure 3). A median of 11.6% (range 0-100%) of S. aureus were methicillin-resistant (MRSA) and the corresponding figures for

ESBL phenotype of E. coli and K. pneumoniae were 3.9% (0-80%) and 14.3% (0-77.8%), respectively. Many ICUs had a high proportion of antibiotic resistant alert pathogens (Table 3 and Figure 3). We found no significant correlations between either presence (I% + R%) or burden (number of resistant patogens/1000 patient days) of MRSA, cephalosporin resistant K. pneumoniae, or carbapenem resistant P. aeruginosa on one hand and total antibiotic consumption or consumption of cephalosporins, quinolones or carbapenems on the other hand. Three ICUs had no standard treatment alternative for *P. aeruginosa* (TA_{90} = 0) in addition to > 35% MRSA and > 55% ESBL K. pneumoniae (Fig. 3 and Table 3). These ICUs had no screening routines for alert organisms but recommended single room for certain alert organisms although there were few or no isolation rooms available (Table 1).

This initial report from CARE-ICU has three main findings. First, antibiotic consumption varied widely from 348 to 4 992 DDD_{1000} with a median consumption of 1254 DDD_{1000}. Second, levels of microbial resistance were very high in many settings. The finding that more than half of all participating ICUs had no, or only one, conventional antibiotic treatment alternative for P. aeruginosa was alarming. Finally, there was a striking lack of isolation rooms for patients colonised or infected with alert organisms.

We calculated antibiotic use as defined daily doses per 1 000 occupied bed days (DDD_{1000}). Although a highly standardised measure that allows the comparison of antibiotic consumption between different settings and countries (http://www.whocc.no/atcddd/ accessed 2008/06/16), a couple of factors complicate such comparisons. First, a common definition for length of stay must be used. Second, antibiotic use was based on the quantities of drugs delivered by each hospital pharmacy, although drugs may be delivered but not administered to patients in the ICU (14-16). A third source of error is that dosing in the critically ill is influenced by many factors other than the DDD (i.e. increased dosing due to life-threatening disease, reduced dosing due to renal impairment). In spite of these difficulties, hospitals were recently recommended to use the DDD methodology to make national and international comparisons of their antibiotic use possible (17).

We found a median antibiotic consumption of 1 417 DDD_{1000} ranging from 348 to 4992 DDD_{1000}. This concurs with figures from European and US ICUs in general (14,18), but like a few ICUs in our programme, relatively low antibiotic consumption has been reported from Switzerland (462 - 683 DDD_{1000}, 19). The lower antibiotic consumption suggests that it is possible to reduce antibiotic consumption in the critically ill, but it has to be accompanied with quality control system to make sure that it does not compromise patient outcomes (19). We found no clear association between the level of antibiotic consumption and rates of microbial resistance to alert pathogens in CareICU. The absence of correlation between antibiotic consumption and resistance rates may be due to differences in the prevalence of colonisation with resistant alert pathogens at admission and the capacity to avoid cross-transmission of these bacteria in the ICUs. For example, the ICU with the lowest antibiotic consumption showed high rates of resistance with a 29% MRSA rate and a high proportion of carbapenem-resistant P. aeruginosa. The most needed intervention in this ICU was probably improvement of hygienic precautions and careful revision of antibiotic guidelines. The greatest consumption of antibiotics reported in our study (4 992 DDD_{1000}) was in a surgical ICU. This unusually large consumption was explained by adding antibiotic treatment on top of a prolonged double-drug peri-operative prophylaxis. Audit of practices lead to a reduction in antibiotic consumption to 1683 DDD_{1000} for 2006. This change to a more appropriate practice, which was preserved during 2007 (personal communication Smilja Kalenic), is one initial result of local audit and benchmarking. The second highest consumption in a neurosurgery ICU may be partly due to an overestimation of prescribed daily dosages since the DDDs defined by WHO are based on sepsis doses and not doses for meningitis. Lemmen et al also found high antibiotic consumption in a Neuro-ICU which was reduced following the launching of a routine infectious disease service (20). Reports from the European Strategy for Antibiotic Prophylaxis also found considerable heterogeneity in the use of antibiotics in 21 European ICUs in six European countries (21).

Resistance proportions were calculated using more than 5 isolates per species. This is a low number but not too low, since the purpose of this project is to develop an early warning system where the presence of a single positive culture of an alert pathogen should lead to action. We also calculated the density, or burden, of resistance to estimate the risk to acquire a resistant pathogen. However, if colonisation cultures were performed on admission or repeatedly during the ICU stay, this would

increase the density of resistance. Therefore to better assess the risk of acquiring a resistant pathogen, density was related to numbers and proportions of resistant isolates.

This study was not designed to evaluate factors and mechanisms that contributed to high rates of MRSA and the ESBL phenotype of E. coli and K. pneumoniae shown in some settings. High resistance rates in the ICU may reflect high prevalence of the same pathogen in the community (http://www.rivm.nl/earss/, accessed 2008/06/16) and entry to ICUs of these clones. Cross-transmission of alert pathogens between patients in the ICU setting should be suspected if the rates of these strains exceed the rates outside the ICU. By monitoring the ICU-rates of resistance of alert organisms and antibiotic consumption it is possible to identify needs for improvement, which may vary over time. Although this programme was designed for annual follow up it may in the future be used more frequently and serve as an early warning system of increased microbial resistance.

Measures to control the transmission of multidrug resistant bacteria are complicated and costly, and their success depends on many factors (22). A reduction in antibiotic use can reduce the emergence of resistance during antibiotic therapy but may be of less importance in outbreaks of epidemic clones of MRSA and ESBL phenotype of K. pneumoniae. The “search and destroy” strategy including MRSA screening at admission has been advocated and successful to control MRSA in many settings (23-26). However, Harbarth et al recently found that rapid MRSA screening at admission plus standard infection control measures vs standard infection control alone did not reduce nosocomial MRSA infection in a surgical department (27). A study from the UK showed that isolation has no impact on MRSA transmission in the ICU (28), but the results have been questioned due to low hand hygiene compliance and that transmission occurred before isolation was started. Current recommendations in most settings include still isolation or cohorting, combined with decolonisation (e.g., mupirocin to the nose and chlorhexidine baths) as major control measures for MRSA (29). If the MRSA rate exceeds 10 %, as it did in half of the ICUs participating in CareICU, it will be impossible to isolate all suspected and proven MRSA-positive patients as the need for isolation rooms will exceed availability. Other measures, including cohort-care of MRSA positive patients, may be used in these settings.

An alarming finding was that more than half of all participating ICUs had no or only oneTA_{90} for P. aeruginosa. Given the low but increasing resistance to colistin (30,31) it is unfortunate that we have no data on colistin resistance among P. aeruginosa, since colistin is still the drug of choice against multidrug resistant P. aeruginosa. We do not know the main reason for the high rates of resistance in P. aeruginosa. However, high consumption of carbapenems and quinolones may be responsible, as may the spread of resistant clones (32-35).

4.2.4 Future perspectives

This study was done in ICUs that showed a particular interest in issues related to antibiotic consumption and microbial resistance, which probably had a positive influence on the response rate of the extensive dataset. Still, all ICUs were not able to submit complete data, particularly information regarding infection control were missing. The case-mix for each ICU was assessed by classifying units according to the ICU-HELICS-programme (http://helics.univ-lyon1.fr/protocols/icu_protocol.pdf, accessed 2008/06/30). However, differences between ICUs within each category were considerable as indicated by a large variation in ICU mortality from 6% to 48.4% with a median 14.5% (data not shown). A further difficulty was whether to separate different ICUs within the same hospital from each other. One such example was a large academic centre where critically ill were treated within separate ICU-modules in the hospital, each with its own distinctive case-mix. Despite differences in case-mix we chose to present these modules together as a single ICU, since it was served by the same infection control team and was presumably challenged by the same alert pathogens prevalent in the hospital and surrounding environment. However, antibiotic consumption from a multi-module ICU becomes less specific and cautious interpretation of the results is necessary.

Benchmarking and audit of antibiotic use and infection control measures has been facilitated by the Care-ICU programme. The web-based application simplifies data collection and the local multi-professional perspective secures that submitted data is valid. Rapid feedback through the web-based protocol is important for confirmation of data entries locally. Routines were also present for validation both at the national and central level. The programme gives clinicians faster and easier access to

results and enables comparisons across hospitals and regions. Continuing efforts are needed to establish best practice as regards antibiotic policy and to improve hygiene measures, which currently vary between and within ICUs, and over time. While there is a lack of evidence as to the most optimal antibiotic strategies for preventing the emergence of bacterial resistance (36), there is consensus that information about usage and cost trends and information about local patterns of bacterial resistance are important steps towards prevention and control of emerging bacterial resistance (22). A model for action based on results from concomitant surveillance of microbial resistance and antibiotic use has been proposed (11). According to this model ICUs with high levels of resistance and low antibiotic use should focus on improved control of cross-transmission, identification of colonised patients at admission and optimising of antibiotic dosing. ICUs with high levels of resistance and high antibiotic use should focus on overuse, misuse and co-usage of antibiotics. Care-ICU provides data for action in agreement with this model and may become an instrument for the promotion of more appropriate use of antibiotics and infection control measures. This may, hopefully, help to reduce emergence and spread of microbial resistance among the critically ill. The CareICU application will during 2009 be transferred to ECDC and integrated in the ECDC run surveillance.

Legends to figures

Fig 4.2.1.
Presence and basis of antibiotic guidelines for ICU-acquired infections in ICUs replying to this part of the questionnaire (N=20).

Fig 4.2.2.
Antibiotic consumption split by major antibiotic classes. DDD_{1000} = Defined daily dose per 1000 occupied bed days (see Methods for details). For ICU short names see footnote Table 1.

Fig 4.2.3.
TA_{90} for Pseudomonas aeruginosa. TA_{90} is the number of antibiotics to which > 90% of isolates of a species were susceptible (see Methods for details). For ICU short names see footnote Table 1.

Legends to tables

Table 4.2.1.
Selected stewardship in infection control.
Footnotes:
[1] The ICU short names consist of the 2 character Internet top level domain name (Cz=Czech Republic, Ee=Estonia, Hr=Croatia, Hu=Hungary, Mt=Malta, Ro=Romania, Se=Sweden, Tr=Turkey) followed by 2 characters for the type of ICU (Me=Medical, Mx=Mixed, Ne=Neonatal, Ns=Neurosurgical, Ot=Other, Su=Surgical, Th=Cardiothoracic) and a sequence number.
[2] ESBL-phenotype was defined as resistance to 3rd generation cephalosporins (see Methods for details)
[3] Multidrug resistance was defined as resistance to ≥ 3 of the 4 tested drugs (aminoglycoside, ceftazidime, ciprofloxacin and carbapenem).

Table 4.2.2.
Microbial resistance (percentage of intermediate susceptible and resistant strains) and number of isolates in parentheses.

Table 4.2.3.
Burden of microbial resistance (resistant pathogens / 1000 patient days), resistance (percentage of intermediate susceptible and resistant strains) and total number of isolates (N). For ICU short names see footnote Table 1.

Table 4.2.1 Stewardship in infection control

	Estonia			Croatia				Hungary			Malta	Romania	Sweden	Turkey
	EeMx1	**EeMx2**	**EeNs1**	**HrMe1**	**HrMx1**	**HrNs1**	**HrSu1**	**HuMx2**	**HuMx3**	**HuOt1**	**MtMx1**	**RoMx1**	**SeMx4**	**TrMx1**
Infection Control (IC) committee	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
ICU physician participating in this committee	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**	**Yes**
IC management team	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Instructions for basic sanitary routines in the ICU	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Education about these instructions (times/year)	**2-3**	**1**	**1**	**1**	**2-3**	**1**	**4**	**1**	**1**	NA	**2-3**	**2-3**	**1**	**1**
Handwashing (soap) facilities in each room	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**
Alcohol based hand disinfection by each bed	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	**Yes**	**Yes**	**Yes**	**Yes**
Disinfectant (liters/1000 patient days)	**247**	**75**	**77**	**48**	**108**	**328**	**536**	NA	**149**	NA	NA	NA	NA	**396**
For patients admitted to ICU:*														
Which Alert organisms are screened for?														
MRSA	No	No	No	No	**Yes**	No	No	**Yes**	No	No	**Yes**	No	**Yes**	No
VRE	No	No	No	No	No	No	No	**Yes**	No	No	No	No	No	No
K. pneumoniae R to third GC (ESBL phenotype)	No	No	No	No	No	No	No	**Yes**	No	No	No	No	No	No
A. baumannii R to CARBS	No	No	No	No	**Yes**	No	No	No	No	No	No	No	No	No
Multidrug resistant Pseudomonas aeruginosa	No	No	No	No	No	No	No	**Yes**	No	No	No	No	No	No
C. difficile	No	No	No	No	No	No	No	No	No	No	No	No	No	No
According to the infection control policy that applies to the ICUs:														
For which patient groups is "Single room" recommended?														
"High risk" patients waiting screening results	**Yes**	No	No	No	**Yes**	No	No	**Yes**	**Yes**	No	No	No	**Yes**	No
Colonised with MRSA (nasal only)	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	No
Colonised with MRSA (other than nasal)	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	No
Patients with glycopeptide resistant Enterococci	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**	**Yes**	No	**Yes**	**Yes**	**Yes**	**Yes**
Patients with K. pneumoniae resistant to third GC	**Yes**	**Yes**	No	No	No	No	No	**Yes**	**Yes**	No	No	No	No	No
Patients with A. baumannii resistant to carbapenems	No	No	No	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No	**Yes**	No	No	No
Patient with multi-drug resistant P. aeruginosa	No	**Yes**	No	No	No	No	**Yes**	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No
Patients with C. difficile diarrhoea	**Yes**	**Yes**	**Yes**	No	**Yes**	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No
Availability of beds														
Beds in single rooms	4/10	1/10	0/8	0/7	0/6	0/8	1/8	0/8	1/8	0/8	3/13	3/30	1/6	6/61
Isolation beds	1/10	1/10	0/8	0/7	0/6	0/8	0/8	0/8	0/8	0/8	1/13	0/30	1/6	6/61

Table 4.2.2 Antibiotic resistance I% +R% (N).

Species / Number of ICU:s	Croatia 4	Czech Rep 3	Estonia 3	Hungary 8	Malta 3	Romania 1	Sweden 10	Turkey 3
Staphylococcus aureus								
Oxacillin	35.2 (91)	3.4 (87)	3.7 (81)	19.6 (291)	60.0 (75)	50.0 (152)	2.2 (136)	92.0 (87)
Aminoglycoside	35.2 (91)	3.4 (87)	4.9 (82)	18.7 (268)	0.0 (65)	44.7 (152)	0.0 (89)	90.2 (82)
Clindamycin	36.3 (91)	9.2 (87)	1.2 (82)	24.7 (263)		0.0 (152)	3.0 (164))	51.7 (87)
Rifampicin	0.0 (91)	0.0 (87)		1.0 (99)	3.3 (61)	38.2 (152)	0.0 (106)	90.1 (71)
Vancomycin	0.0 (91)	0.0 (87)	0.0 (82)	0.0 (266)	0.0 (63)	0.0 (152)	0.0 (128)	0.0 (108)
Escherichia coli								
3rd generation cephalosporin	3.6 (83)	1.3 (153)	5.0 (100)	18.0 (172)	3.1 (32)	24.0 (75)	1.6 (123)	42.0 (50)
Ciprofloxacin	11.0 (91)	4.6 (153)	2.0 (100)	18.4 (244)	25.0 (32)	18.7 (75)	5.9 (101)	34.4 (61)
Imipenem	0.0 (65)	0.0 (153)	0.0 (95)*	1.1 (189)	0.0 (32)	0.0 (75)	0.0 (64)	0.0 (57)
Aminoglycoside	6.6 (91)	5.2 (153)	4.0 (99)	12.1 (240)	9.4 (32)	26.7 (75)	0.0 (58)	34.5 (55)
Acinetobacter baumannii								
Ceftazidime	53.2 (62)	23.8 (42)		82.3 (113)	90.9 (44)	86.7 (120)	83.3 (6)	89.6 (115)
Ciprofloxacin	90.3 (62)	23.8 (42)	72.7 (11)	92.5 (107)	93.2 (44)	95.0 (120)	20.0 (5)	69.6 (115)
Imipenem	17.7 (62)	4.8 (42)	0.0 (12)	15.2 (112)	90.9 (44)	11.7 (120)	0.0 (5)	38.5 (117)
Aminoglycoside	50.0 (62)	23.8 (42)	66.7 (18)	79.0 (105)	93.2 (44)	98.3 (120)	0.0 (4)	80.2 (111)
Enterobacter cloacae								
3rd generation cephalosporin		17.8 (73)	33.3 (6)	18.2 (11)	61.5 (13)	44.4 (18)	20.0 (25)	29.4 (17)
Ciprofloxacin		0.0 (73)	0.0 (6)	16.7 (12)	0.0 (13)	0.0 (18)	2.9 (34)	5.9 (17)
Imipenem		0.0 (73)	0.0 (3)	0.0 (14)	0.0 (13)	0.0 (18)	3.1 (32)	6.3 (16)
Aminoglycoside		0.0 (73)	0.0 (6)	16.7 (12)	30.8 (13)	33.3 (18)	4.5 (22)	17.6 (17)
Pseudomonas aeruginosa								
Ceftazidime	11.0 (127)	34.4 (122)	5.5 (109)	10.7 (373)	9.7 (62)	34.0 (94)	11.0 (73)	48.3 (89)
Ciprofloxacin	36.2 (127)	28.9 (121)	5.0 (100)	20.5 (346)	23.8 (63)	55.3 (94)	12.2 (74)	37.8 (90)
Imipenem	28.3 (127)	30.3 (122)	13.7 (51)	18.8 (377)	25.4 (63)	10.6 (94)	17.3 (52)	48.4 (93)
Aminoglycoside	43.3 (127)	26.2 (122)	4.7 (107)	22.7 (343)	9.3 (54)	57.4 (94)	0.0 (24)	53.5 (86)
Klebsiella pneumoniae								
3rd generation cephalosporin	17.8 (45)	9.0 (122)	18.5 (54)	29.0 (62)	16.7 (12)	62.7 (118)	0.0 (18)	52.6 (38)
Ciprofloxacin	21.3 (47)	16.4 (122)	5.6 (72)	13.2 (76)	8,3 (12)	37.3 (118)	0.0 (18)	21.4 (42)
Imipenem	0.0 (49)	0.0 (122)	0.0 (73)*	1.1 (94)	0.0 (12)	0.0 (118)	0.0 (14)	13.6 (44)
Aminoglycoside	17.0 (47)	7.4 (122)	5.5 (73)	17.3 (75)	8.3 (12)	69.5 (118)	0.0 (15)	45.0 (40)

*Meropenem

Table 4.2.3 Burden of Antibiotic Resistance (Resistant pathogens / 1000 patient days)

	Methicillin resistant *Staphylococcus aureus*			**Cephalosporin resistant *Klebsiella pneumoniae***			**Carbapenem resistant *Pseudomonas aeruginosa***		
ICU	**Burden**	**I%+R%**	**N**	**Burden**	**I%+R%**	**N**	**Burden**	**I%+R%**	**N**
CzMe1	0.7	9.5	21	1.5	10.3	39	8.5	53.5	43
CzNs1	0.4	2.3	43	2.5	16.3	43	3.5	28.6	35
CzTh1	0.0	0	23	0.0	0	40	1.6	9.1	44
EeMx1	0.0	0	24	2.7	29.2	24	1.9	9.1	55
EeMx2	0.4	14.3	7	0.0	-	2	0.4	2.5	40
EeNs1	1.0	4	50	1.4	10.7	28	0.0	0.0	14
HrMe1	3.7	57.9	19	0.7	14.3	14	6.1	42.9	42
HrMx1	0.0	0	10	0.0	0	8	2.9	13.9	36
HrNs1	9.5	23.4	47	5.2	26.1	23	5.2	25.0	24
HrSu1	12.6	66.7	15	2.5	-	2	8.8	28.0	25
HuMe1	1.0	23.8	21	0.4	33.3	6	0.8	19.0	21
HuMx1	3.0	13.6	88	0.0	-	2	2.5	14.9	67
HuMx2	0.0	0	56	0.0	0	16	5.7	10.3	156
HuMx3	7.8	29	69	1.2	15.8	19	5.5	36.8	38
HuNs1	1.0	13.6	22	2.4	29.2	24	3.1	30.0	30
HuOt1	0.9	37.5	8	2.1	77.8	9	2.1	38.9	18
HuSu1	2.1	57.1	14	0.3	12.5	8	2.1	36.4	22
HuTh1	1.7	46.2	13	0.3	7.7	13	0.9	12.0	25
MtMx1	5.7	64.1	39	0.2	14.3	7	3.6	30.2	53
RoMx1	4.3	50	152	4.1	62.7	118	0.6	10.6	94
SeMx2	0.6	7.7	13	0.0	-	2	1.3	33.3	6
SeMx3	0.0	0	22	0.0	-	2	0.0	0.0	6
SeMx4	0.0	0	10	0.0	-	2	0.0	0.0	1
SeMx5	0.0	0	33	0.0	-	1	1.6	20.0	15
SeMx6	0.5	4.5	22	0.0	-	3	0.0	-	0
SeTh2	0.0	0	11	0.0	-	3	0.6	25.0	4
TrMe1	3.0	60	5	2.0	-	2	1.0	14.3	7
TrMx1	5.3	94.4	71	1.6	58.8	34	2.9	47.4	78
TrSu1	7.7	100	9	0.0	-	4	6.0	100.0	7

Figure 4.2.1

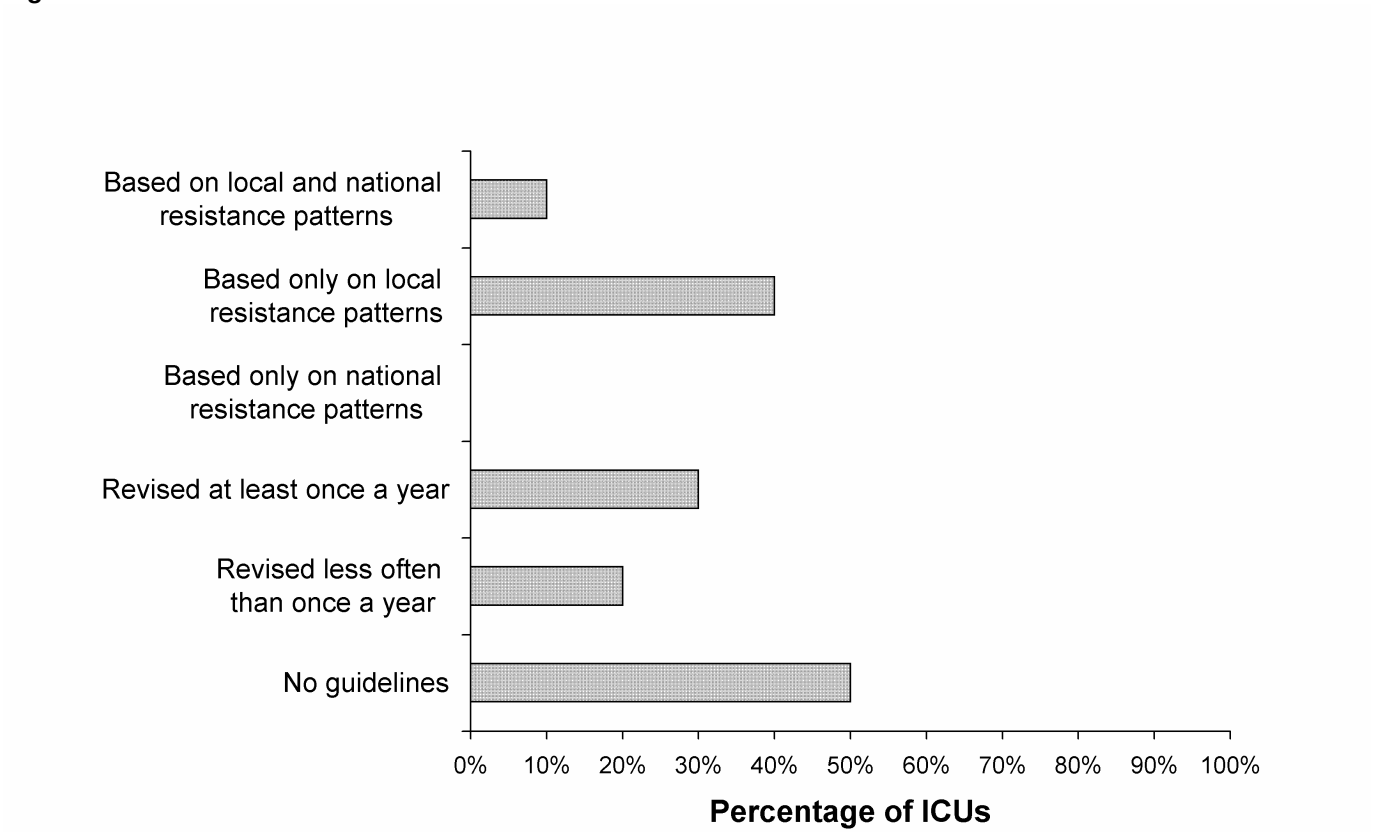

Based on local and national resistance patterns
Based only on local resistance patterns
Based only on national resistance patterns
Revised at least once a year
Revised less often than once a year
No guidelines
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentage of ICUs

Figure 4.2.2

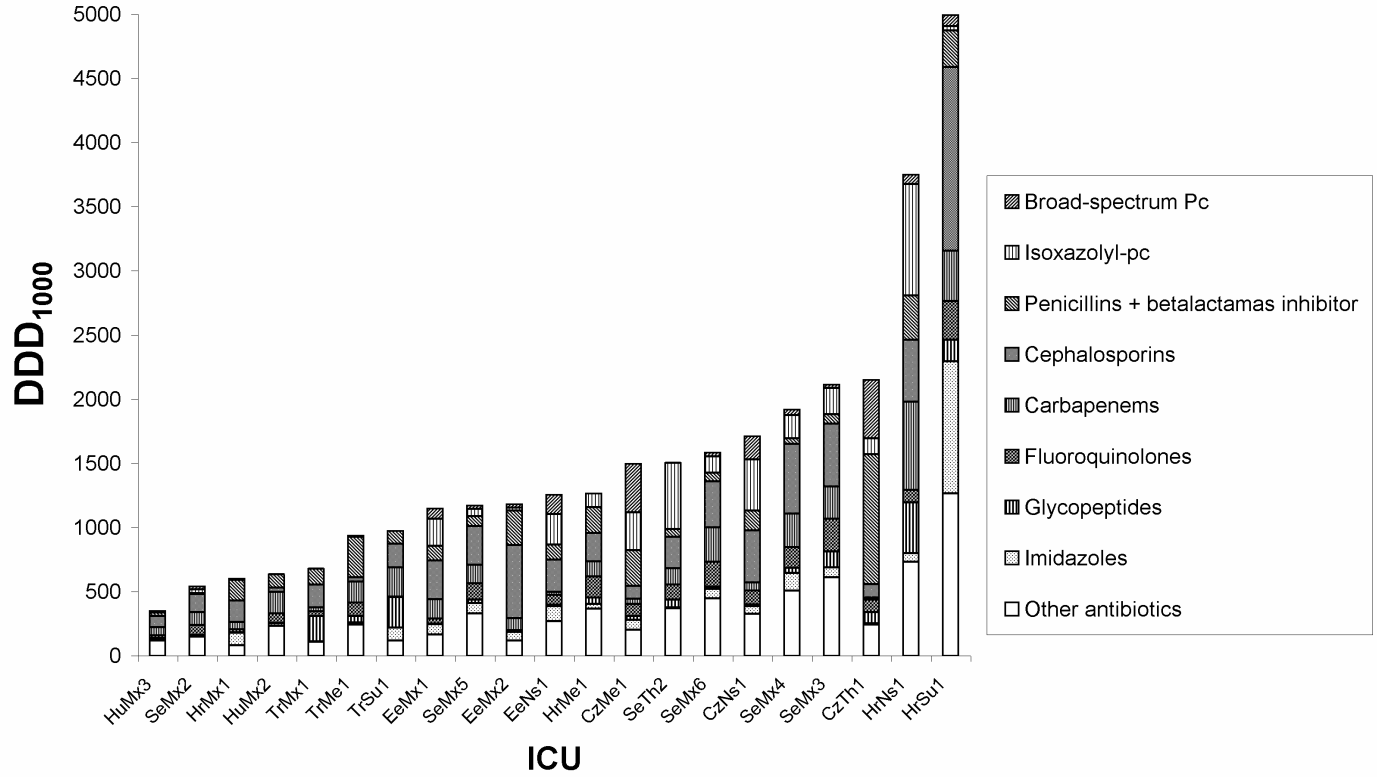
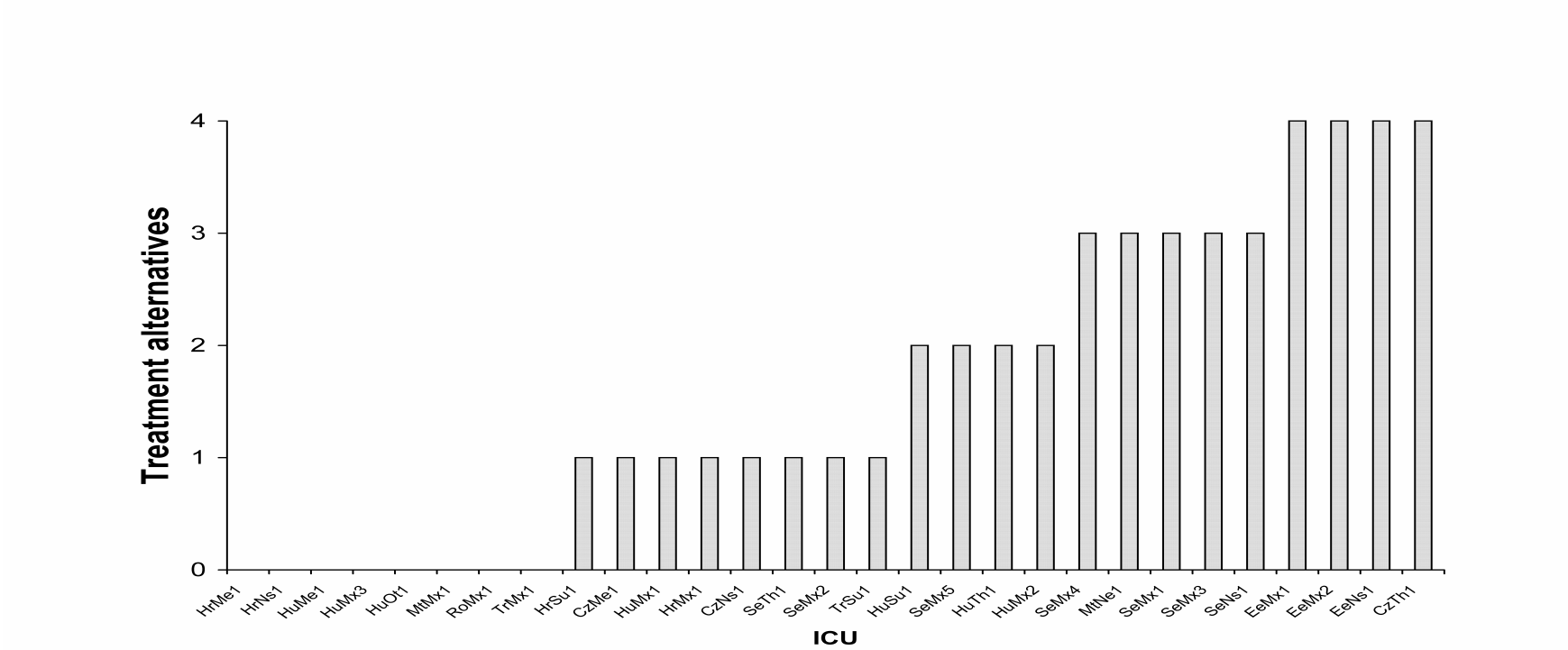

5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
DDD1000
HuMx3
SeMx2
HrMx1
HuMx2
TrMx1
TrMe1
TrSu1
EeMx1
SeMx5
EeMx2
EeNs1
HrMe1
CzMe1
SeTh2
SeMx6
CzNs1
SeMx4
SeMx3
CzTh1
HrNs1
HrSu1
ICU
Broad-spectrum Pc
Isoxazolyl-pc
Penicillins + betalactamas inhibitor
Cephalosporins
Carbapenems
Fluoroquinolones
Glycopeptides
Imidazoles
Other antibiotics

Figure 4.2.3


Treatment alternatives
0
1
2
3
4
HrMe1
HrNs1
HuMe1
HuMx3
HuOt1
MtMx1
RoMx1
TrMx1
HrSu1
CzMe1
HuMx1
HrMx1
CzNs1
SeTh1
SeMx2
TrSu1
HuSu1
SeMx5
HuTh1
HuMx2
SeMx4
MtNe1
SeMx1
SeMx3
SeNs1
EeMx1
EeMx2
EeNs1
CzTh1
ICU

4.3 Analysing Cross-transmission, Import and Export of Antimicrobial Resistance (AMR) in Intensive Care Units (ICUs)

4.3.1 Objectives

It should be noted that the hospital is not the only environment for the emergence and spread of AMR. There is an increasing number of reports on the emergence of AMR in the community. The spread of resistant pathogens in and outside of the hospital poses an enormous thread to personal and public health. Therefore, the objectives of IPSE Work Package 6 were:

- to define the resistance-pool constantly present at a high incidence- and/or prevalence-rate affecting all in-patients of a specific hospital ICU, i. e. to define the "AMR equilibrium" in the ICU.

- to define the exchange, i. e. import and export of resistant bacteria between ICUs and the community.

- to correlate, if possible, genotyping data of resistant bacteria with antibiotic consumption data of "outlier ICUs" (WP5).

4.3.2 Methods

Over the past decades, resistance patterns to antimicrobial agents have changed dramatically. This is particularly true for ICUs, where increasing prevalence rates of methicillin-resistant *Staphylococcus aureus (MRSA),* and gram-negative bacteria can be found. Therefore, pathogens of interest for IPSE WP6 were:

- *Staphylococcus aureus* isolates, resistant to methicillin,
- *Enterococci*, resistant to glycopeptides,
- *E. coli* and *Klebsiella pneumoniae*, resistant to 3rd generation cephalosporins, including ESBL – producing strains, and resistant to fluoroquinolones,
- *Pseudomonas aeruginosa* and *Acinetobacter baumannii* isolates, resistant to fluoroquinolones and carbapenems.

All ICUs participating in HELICS/IPSE being aware of a "resistance problem" were requested to collect resistant bacterial isolates of interest along with patient data. Bacterial isolates were mailed to the Institute of Environmental Medicine and Hospital Epidemiology (IEMHE) Reference Laboratory in Freiburg, Germany for genotyping. For this purpose, a protocol for patient data-collection and genotyping was provided on the IPSE-Website. Items requested by the IEMHE Reference Laboratory were at least 20 resistant isolates of each bacterial species, and10 cross-sectional isolates of each species, irrespectively of AMR along with the accompanying "Microbiology Isolate Report From". Furthermore, the local microbiology laboratories were requested to report their antimicrobial susceptibility testing methods and quality assurance standards and to provide information on their national regulations for shipping of "safety-level 2 organisms". Isolates were shipped either through the national centres of each country or directly to Freiburg. The genotyping methods for the resistant bacteria available and implemented at the IEMHE were:

- for *Staphylococcus aureus*: Pulsed-Field Gel Electrophoresis (PFGE), spa-typing and Multi-Locus Variable Number of Tandem Repeat Analysis (MLVA)
- for *Enterococci*: PFGE and MLVA,
- for *E. coli* and *Klebsiella pneumoniae*: Amplified Fragment Length Polymorphism (AFLP)
- for *Pseudomonas aeruginosa*: AFLP and MLVA
- for *Acinetobacter baumannii*: AFLP.

The expected outcomes of genotyping were to produce data for defining a resistance pool constantly present at a high incidence and/or prevalence rate affecting ICU patients and the implementation of a complementary educational tool for antimicrobial drug use and infection control programs.

4.3.3 Main achievements

A total of 21 ICUs from 6 European countries participated, provided patient data and collected bacterial strains for genotyping:

- 8 ICUs from Italy,
- 5 ICUs from Germany,
- 5 ICUs from Slovakia,
- 1 ICU each from Hungary, Malta and Romania.

The period for collecting clinical isolates was from January 2004 to June 2007. A total of 425 data-sets were recruited; of these, 331 were on resistant pathogens, and 94 on non-resistant pathogens. Of 320 in-patients, 104 were colonised and 196 were infected with resistant micro-organisms. Data from 20 patients were incomplete. Micro-organisms sent for genotyping by country are represented in Figures 4.3.3.1 and 4.3.3.2.

Figure 4.3.3.1: Resistant microorganisms sent for genotyping by country

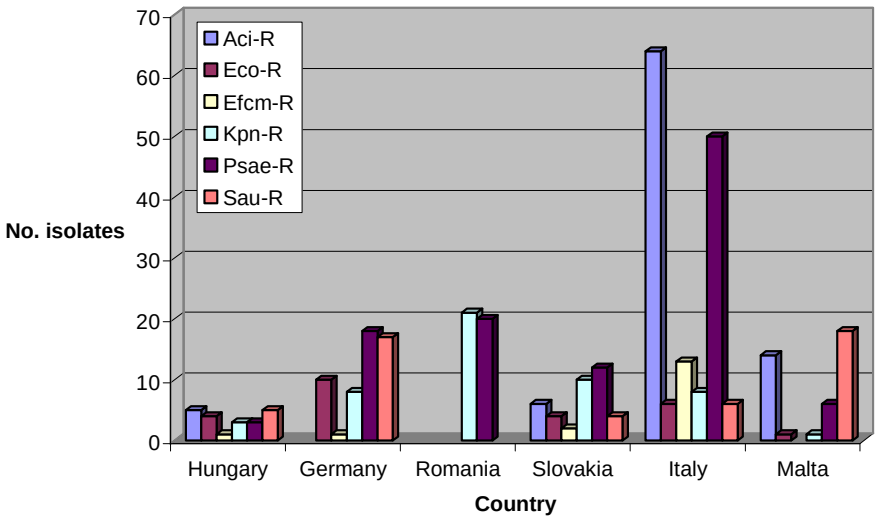
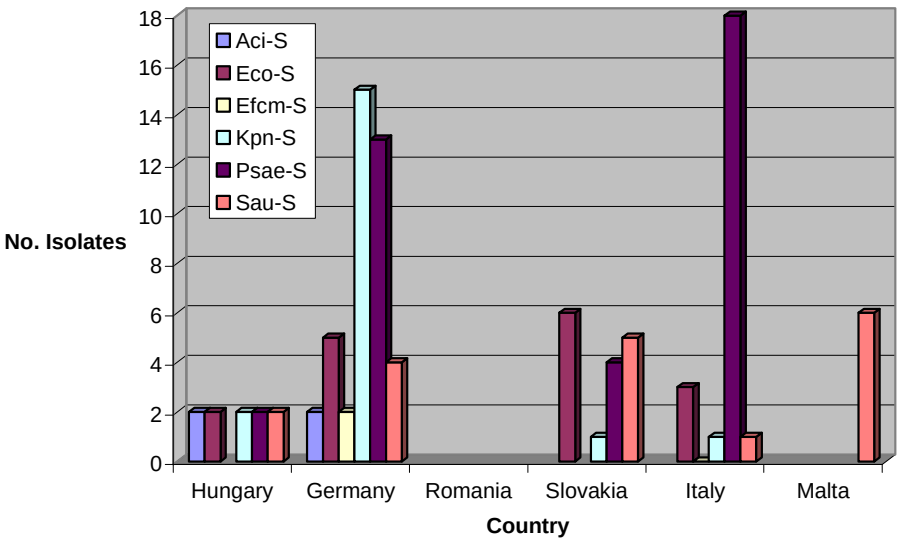


Figure 4.3.3.2: Susceptible microorganisms sent for genotyping by country



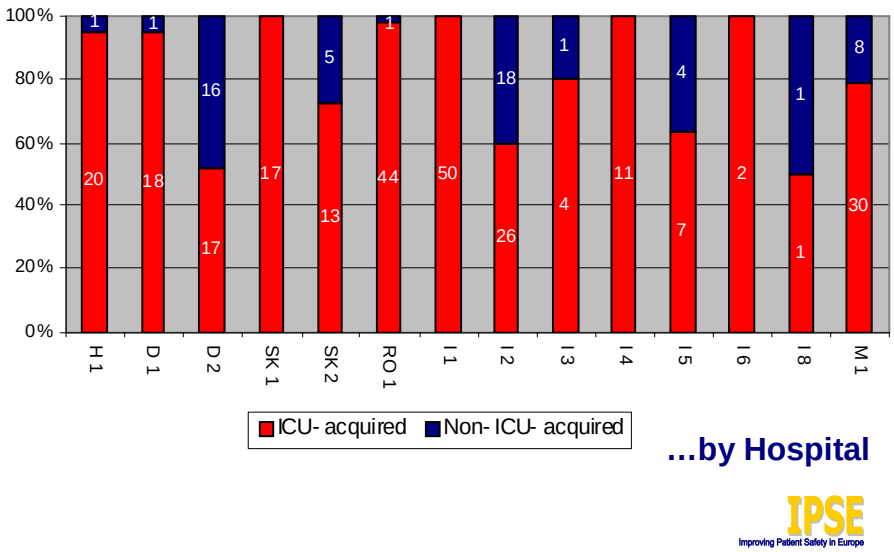
The majority of resistant *Acinetobacter baumannii* and *Pseudomonas aeruginosa* isolates was collected in Italy, where ICUs were known to have problems with these resistant organisms. A total of 425 clinical isolates were sent for genotyping to the reference-laboratory.

In detail, there were:

- 154 isolates of *Pseudomonas aeruginosa*,
- 79 of *Acinetobacter baumannii*,
- 70 of *Klebsiella pneumoniae*,
- 68 of *Stapylococcus aureus*,
- 45 of *Escherichia coli* and
- 18 of *Enterococcus faecium*.

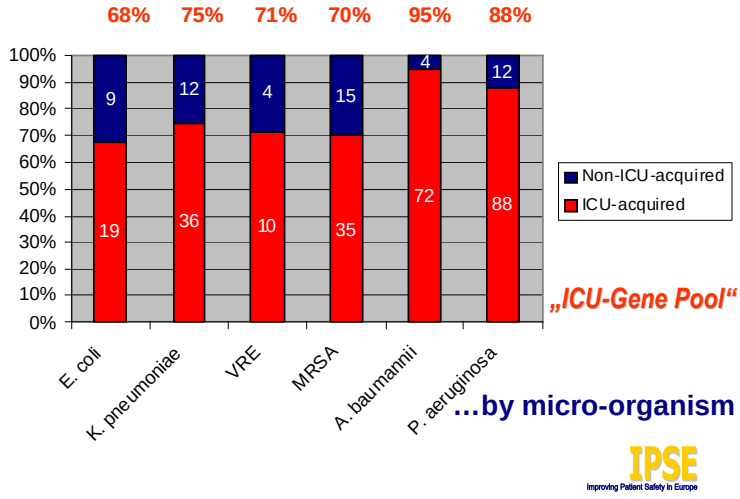
The vast majority of resistant micro-organisms was acquired in the ICU (Figure 4.3.3.3).

Figure 4.3.3.3: ICU-acquired and Non-ICU-acquired AMR



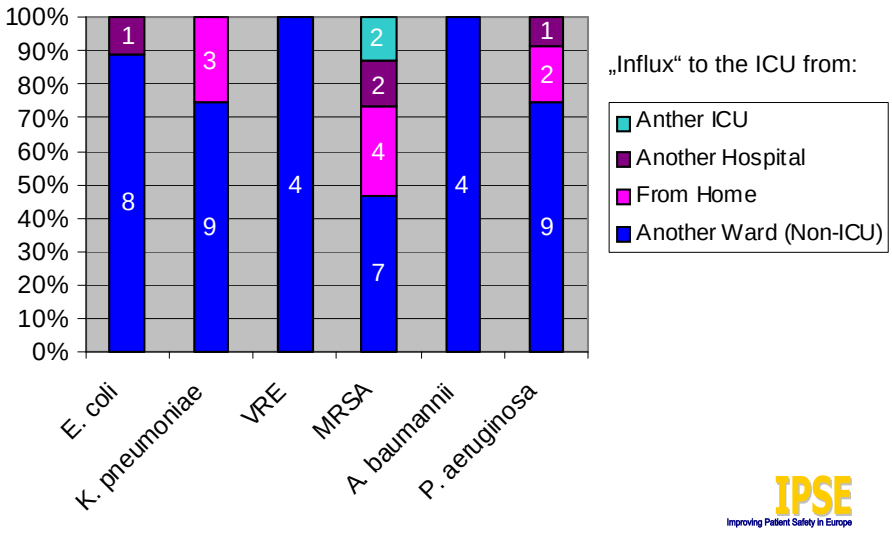
Approximately two thirds (68%) of *E. coli*, three quarters (75%) of *Klebsiella pneumoniae*, 61 % of *VRE*, 70% of *MRSA* and 88% of *Pseudomonas aeruginosa* were transmitted within the ICU. The highest transmission-rate was found for *Acinetobacter baumannii* (95%; Figure 4.3.3.4).

Figure 4.3.3.4: ICU-acquired and Non-ICU-acquired AMR



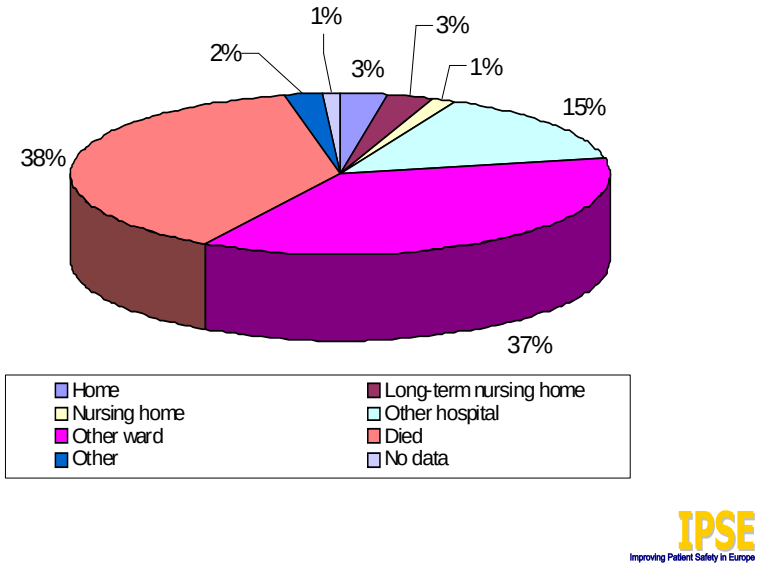
The majority of non-ICU-acquired microbial-resistant organism stemmed from other wards within the same hospital (Figure 4.3.3.5).

Figure 4.3.3.5: Origin of Non-ICU- acquired AMR



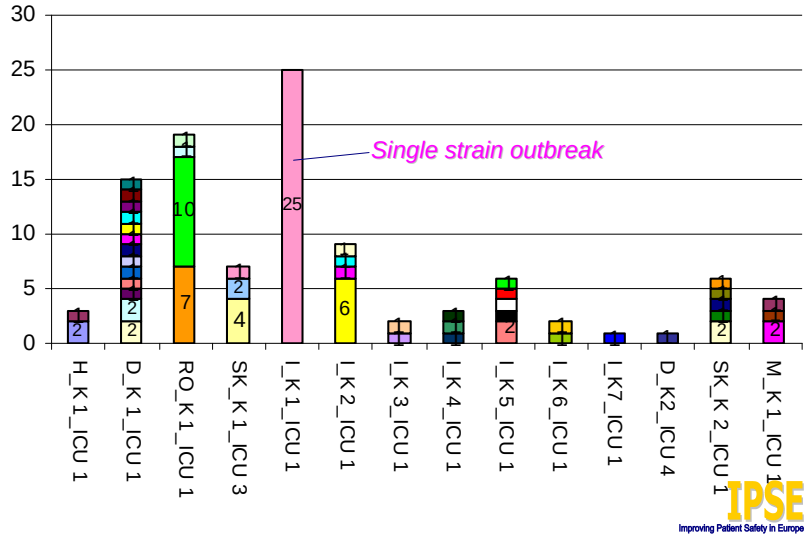
More than 1/3 (38%) of ICU patients with resistant organisms died within the ICU, 37% were discharged to another ward of the same hospital (Figure 4.3.3.6).

Figure 4.3.3.6: Discharge of patients with AMR



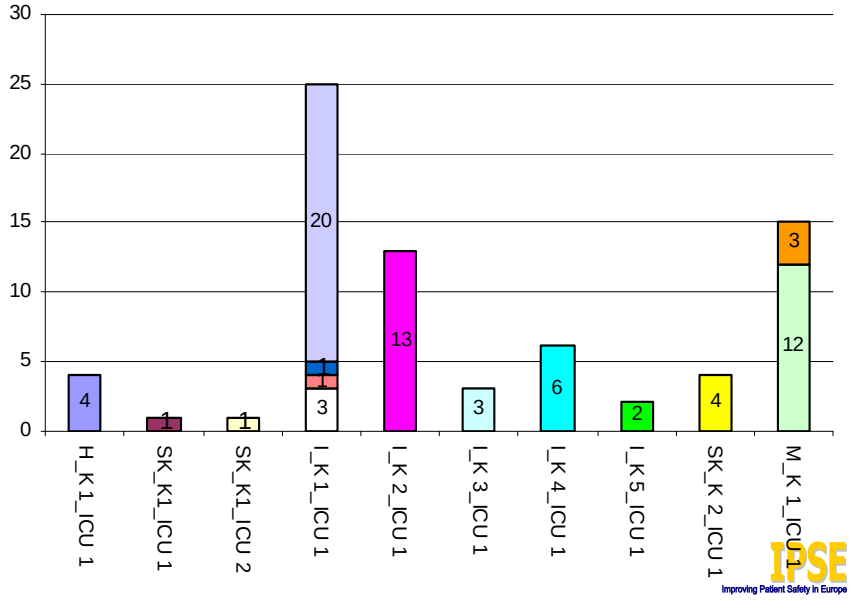
Processing and analysis of DNA-fingerprints and sequences was performed by use of BioNumerics / BURST software. Data were analysed by ICU-based assignation of genotypes. Genotyping results for *Pseudomonas aeruginosa* revealed at least in two Italian hospitals and in one Romanian hospital endemic single strains of *Pseudomonas aeruginosa*, possibly causing outbreaks in the ICU (Figure 4.3.3.7).

Figure 4.3.3.7: Genotyping results for *P. aeruginosa*



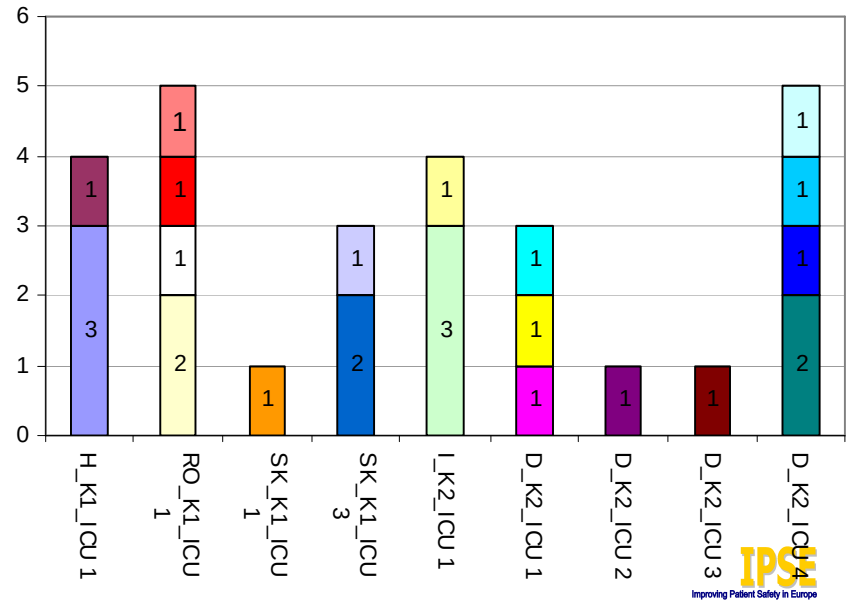
Single strains of *Acinetobacter baumannii* were found at least in three Italian ICUs and in one ICU each in Malta, Slovakia and Hungary (Figure 4.3.3.8).

Figure 4.3.3.8: Genotyping results for *A. baumannii*



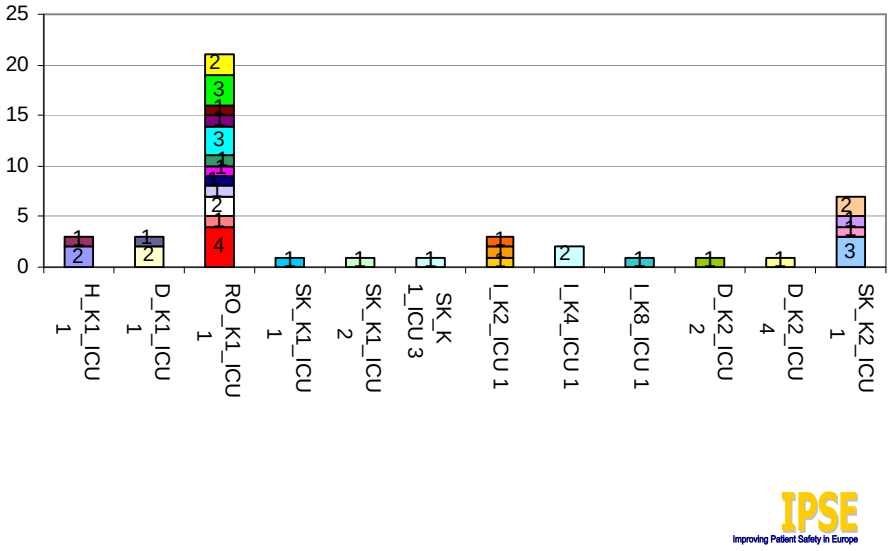
Genotyping of *Escherichia coli* demonstrated a high diversity of isolates in the ICU setting. Three identical isolates were found in one Italian as well as in one Hungarian ICU (Figure 4.3.3.9).

Figure 4.3.3.9: Genotyping results for *Escherichia coli*



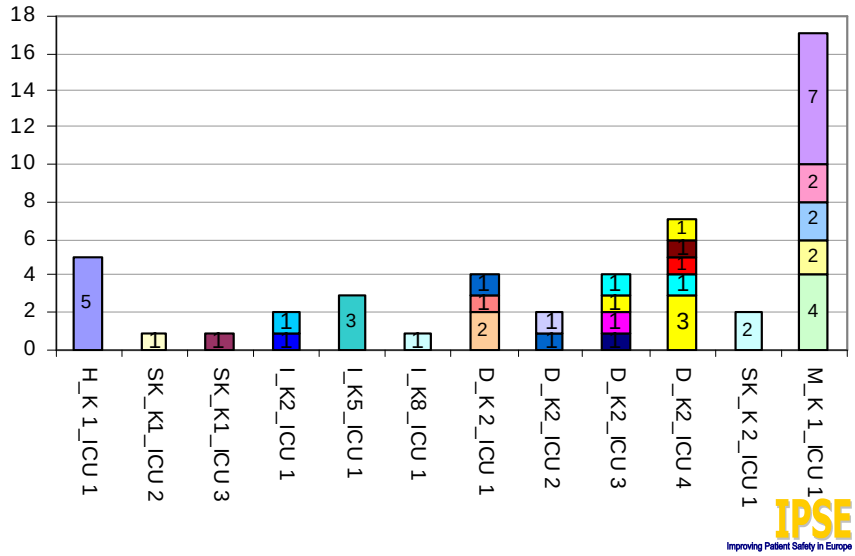
Similar results were found for *Klebsiella pneumoniae* with four identical isolates in one Romanian ICU and three identical isolates in a Slovakian ICU (Figure 4.3.3.10).

Figure 4.3.3.10: Genotyping results for *Klebsiella pneumoniae*



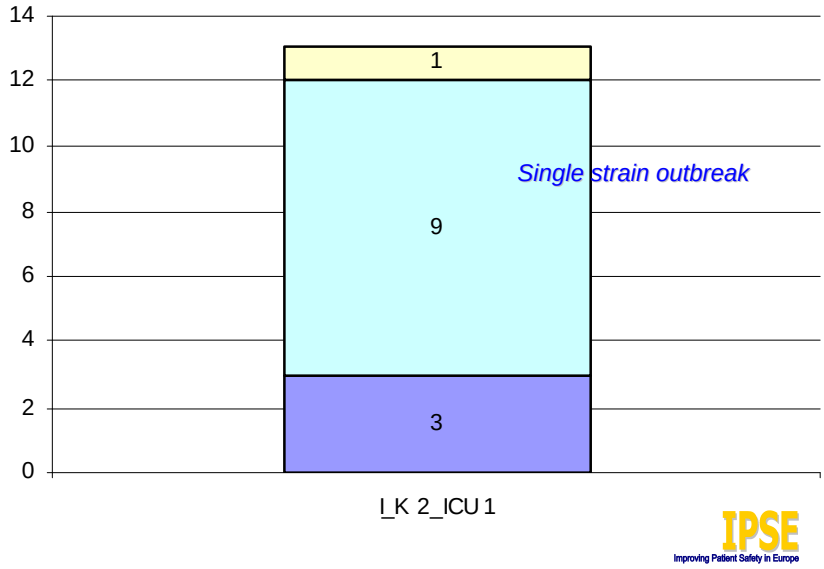
A high endemicity of *MRSA* strains was found not only in Malta and Hungary, but also in Germany (Figure 4.3.3.11).

Figure 4.3.3.11: Genotyping results for MRSA



Genotyping results for *Enterococcus faecium* showed an single strain VRE outbreak in one Italian ICU with nine genotypically identical isolates (Figure 4.3.3.12).

Figure 4.3.3.12: Genotyping results for VRE



The genodiversity of resistant organisms prevalent in a specific ICU can be determined by the "genodiversity index". This index can be calculated as the unit-based diversity of the number of genotypes minus 1 divided by the number of strains investigated minus 1.

The genodiversity index can be of practical use since ICUs with a high diversity of resistant strains (diversity index = 1) may influence their resistance problem by improving the antibiotic policy, where as ICUs with a low diversity index (= 0) may influence their resistance rates by increasing infection control measures. Results of the diversity index are given in Figure 4.3.3.13.

Figure 4.3.3.13: Genodiversity indices of resistant pathogens in different ICUs

Country	ICU	Diversity Index						
		Aci	*Efcm*	*Eco*	*Kpn*	*Psae*	*Sau*	
Germany	D_K1_ICU 1	-	-	-	0,50	0,86	-	
	D_K2_ICU 1	-	-	1	-	-	0,67	
	D_K2_ICU 2	-	-	-	-	-	1	
	D_K2_ICU 3	-	-	-	-	-	1	
	D_K2_ICU 4	-	-	0,75	-	-	0,67	
Hungary	H_K1_ICU 1	0	-	0,33	0,50	0,50	0	
Italy	I_K1_ICU 1	0,13	-	-	-	0	-	
	I_K2_ICU 1	0	0,17	0,33	1	0,38	1	
	I_K3_ICU 1	0	-	-	-	1	-	
	I_K4_ICU 1	0	-	-	0	1	-	
	I_K5_ICU 1	0	-	-	-	0,80	0	
	I_K6_ICU 1	-	-	-	-	1	-	
	I_K7_ICU 1	-	-	-	-	-	-	
	I_K8_ICU 1	-	-	-	-	-	-	
Malta	M_K1_ICU 1	0,07	-	-	-	0,67	0,25	
Romania	RO_K1_ICU 1	-	-	0,75	0,55	0,17	-	
Slovakia	SK_K1_ICU 1	-	-	-	-	-	-	
	SK_K1_ICU 2	-	-	-	-	-	-	
	SK_K1_ICU 3	-	-	0,5	-	0,33	-	
	SK_K1_ICU 4	-	-	-	-	-	-	
	SK_K2_ICU 1	0	-	-	0,50	0,80	0	

Our data do not support the hypothesis that long term care facilities or nursing homes are an important source for the import or export of resistant pathogens in the ICU. We could, however, demonstrate that many ICUs in Europe have AMR problems due to cross- transmission with endemic resistant organisms, e. g. *MRSA, VRE, E. coli, K. pneumoniae*, *Acinetobacter baumannii* and *Pseudomonas aeruginosa*.

4.3.4 Future perspectives

In IPSE WP6, a total of 21 ICUs from six European countries collected resistant bacterial strains for genotyping. Analysing these data, it was possible to characterize AMR gene pools in the ICUs. To a certain degree, it was possible to estimate the import and export of resistant bacteria in ICUs from and to the community. In the future, participation of a large number of HELICS/IPSE ICUs could be helpful to identify and map the emergence and spread of resistant bacterial clones within Europe. Another objective of WP6 which has not been met yet would be to correlate the genodiversity of antimicrobial resistant bacterial species with the varying values of the antimicrobial usage density. The hypothesis, that resistance rates in Intensive Care Units are markedly influenced by cross-transmission events and additional to high rates of antimicrobial usage might be proven by continuing research in this field.

5.0 Future Strategies for Patient Safety in Europe

Definition of a set of future initiatives for Improving Patient Safety in Europe benefits from the interventions and discussions amongst experts who attended the final project meeting in Lyon (May 23, 2008), from the remarks made during the ECDC hub visit (2008) and from the preparation of the transition plan of the IPSE/HELICS database from University Claude Bernard to ECDC.

Such a transition will be a major opportunity for continuous European collaboration for patient safety. It will allow production of reference data, extension of surveillance and follow-up of epidemiological trends in EU Member States. In learning from each other, Member States will be able to assess the strengths & weaknesses of their own surveillance through comparison and additionally will be able to develop risk models and assess the burden of HCAI. The production and dissemination of four common surveillance protocols is a major achievement for future initiatives.

Several objectives have been proposed and discussed within the IPSE/HELICS network with much interest expressed by scientists, professionals and representatives of healthcare organisations:

5.1. To maintain the network and its coordinated activities

The fact that the HELICS/IPSE-associated networks will become an ECDC network on HCAI is widely appreciated by network members. The constitution and maintenance of a steering group (according to rules of the ECDC Management Board) is considered desirable, with resources allocated to periodic meetings of the steering group and the entire network. Information technologies should be available for animating the network.

5.2 To stabilise and strengthen outcome surveillance

Once transferred to ECDC, the necessary resources and time should be available for its timely management. Strategy and methods should be implemented for assessing and assuring the quality and comparability of the data produced by the networks. This may require the setting up of a specific project covering the need of data validity evaluation in healthcare-associated networks.

SSI/ICU surveillance should be extended to all EU countries, possibly for representative samples of hospitals in some countries, to provide a reliable picture of the EU situation and time trends. It has been suggested that ECDC site visits should be organised more systematically to stimulate participation and foster the use of local data when they are collected through specific national systems.

Considering future steps of surveillance, ECDC should support the development of information technology allowing the extraction of critical data (infections, micro-organisms, antibiotic resistance patterns and treatment, risk factor, etc.) from hospital databases (lab, clinical data, OR data, pharmacy, etc.). An EU information technology research programme could be considered on data and text mining (“medical intelligence systems”). By adopting this integrated approach, the perspective of a coherent ECDC package covering patient safety issues with EARSS, ESAC and others, integrating IPSE/HELICS surveillance (HELICS + CARE-ICU) would be realistic.

5.3 To consider new (outcome and process) surveillance targets

A global assessment of HCAI in acute care hospitals is feasible through harmonisation of national prevalence protocols. An agreed protocol and timetable for national prevalence surveys should lead to an harmonised European prevalence survey. This will require that EU countries collaborate in managing a common set of definitions of HCAI (preferably with those existing in the USA).

Of particular importance should be a specific project for assessing safety in long-term care facilities associating prevalence of HCAI (following the IPSE WP7 protocol) with resources and process indicators. It could complement the present surveillance activities supported by EU-ECDC.

Using the indicators developed in the context of IPSE WP2, a public disclosure (mapping) of selected process indicators reflecting the advancement of policy in Member States would be a central

initiative if Member States accept the benchmarking of their involvement in a structured infection control policy. It could be organised jointly by WHO and EU-ECDC. Special consideration should be given to Hand Hygiene in collaboration with WHO Global Patient Safety Challenge and “Clean Care is Safer Care” programme.

C. difficile epidemic infections (particularly ribotype 027) are an important cross-border challenge for surveillance and control: this could be adressed in an initiative relying on a network of surveillance institutes and reference laboratories. Other emerging pathogens (e.g. PVL+ CA-MRSA and animal MRSA ST398) could be included in such laboratory-based surveillance schemes.

5.4 To help countries

Given the fact that HCAI surveillance and control remain a difficult issue for national and local patient safety policy, ECDC should continue the work done by the HELICS and IPSE networks in implementing recommended standards, indicators and training. ECDC country visits could be excellent opportunities to review the national situation for all healthcare related patient safety issues: surveillance and control of HCAI, AMR and other adverse events. On these occasions the harmonisation of indicators and of training programmes should be considered. On the request of countries, EU-ECDC could provide guidance and support for developing national training schemes for surveillance and control of HCAI and AMR and initiatives could be undertaken for mobilising national decision makers and politicians on patient safety issues (seminars, training, awards, etc.).

Specifically ECDC should support the efforts of ESCMID for strengthening the training of infection control practitioners by organising an *European course on Surveillance, investigation and evaluation methodologies for HCAI control*. Such a course could contribute to national training.

5.5 To increase responsiveness to emerging problems

A European information system should allow rapid communication on new and threatening nosocomial events, not only through the official European alert (EWRS), but also through a forum of dissemination and discussion of information on significant new or threatening events which are not subject to official inter-state notification.

If required, ECDC should create conditions for providing expert support to countries, particularly in the case of cross-border nosocomial threats.