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Status of infection control policies and organisation in European hospitals, 2001: the ARPAC study

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ABSTRACT

Patient safety in hospital care depends on effective infection control (IC) programmes. The Antimicrobial Resistance Prevention and Control (ARPAC) study assessed the organisation, components and human resources of IC programmes in European hospitals. A questionnaire survey of policies and procedures implemented in 2001 for the surveillance and control of nosocomial infection and antibiotic resistance was completed by 169 acute-care hospitals from 32 European countries, categorised by five geographical regions. A formal IC programme existed in 72% of hospitals, and a multidisciplinary IC committee was operational in 90%. Trained IC nurses (ICNs) were present in 80% of hospitals (ranging from 54% in south-east and central-eastern Europe, to 100% in northern Europe), whereas 74% had one or more trained IC doctors (ICDs) (ranging from 46% in south-east Europe to 84% in western Europe). Median staffing levels were 2.33 ICNs/1000 beds and 0.94 ICDs/1000 beds. The intensity of IC programmes scored higher in centres from northern and western Europe than from other European regions. Written guidelines promoted hand hygiene for healthcare workers in 89% of hospitals, education in 85%, and audit in 46%. Guidelines recommended use of alcohol-based solutions (70%) and/or medicated/antiseptic soap (43%) for decontamination of non-soiled hands. Use of alcohol-based solutions varied according to region, from 41% in southern Europe to 100% in northern Europe, compared with use of medicated soap from 77% in southern Europe to 11% in northern Europe ($p < 0.01$). These findings showed that IC programmes in European hospitals suffer from major deficiencies in human resources and policies. Staffing levels for ICNs were below recommended standards in the majority of hospitals. Education programmes were incomplete and often not supported by audit of performance. Hand hygiene procedures were sub-standard in one-third of centres. Strengthening of IC policies in European hospitals should be a public health priority.

Keywords ARPAC, cross-infection, education, hand-hygiene, infection control policies, nosocomal infection

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INTRODUCTION

Antimicrobial resistance is fuelled by selection and transmission of antimicrobial-resistant bacteria in acute-care hospitals, where they add to the health and economic burden of nosocomial infection [1]. Acknowledgement of this threat has prompted publication of recommendations and action plans by national and international health

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agencies [2,3]. These recommendations call for prudent use of antimicrobial agents, as well as better prevention and control of infection. However, the public and the media express growing concern about the safety of hospital care and the effectiveness of infection prevention programmes.

The Antibiotic Resistance Prevention and Control (ARPAC) project was a Concerted Action supported by the European Commission and carried out by four Study Groups of the European Society of Clinical Microbiology and Infectious Diseases (ESCMID), namely the ESCMID Study Group on Antibiotic Policies (ESGAP), the ESCMID Study Group for Antimicrobial Resistance Surveillance (ESGARS), the ESCMID Study Group on Nosocomial Infections (ESGNI), and the ESCMID Study Group on Epidemiological Markers (ESGEM). The ARPAC study was launched in 2002, with the aims of laying the foundations for a better understanding of the causes of variations in the prevalence and spread of antibiotic resistance, and of evaluating and harmonising strategies for prevention and control of antibiotic-resistant pathogens in hospitals in Europe. One specific objective of ARPAC was to describe the general hospital infection control (IC) infrastructure, organisation, policies and procedures implemented in acute-care hospitals throughout Europe. This paper presents the retrospective data for 2001 from participating ARPAC hospitals in 32 European countries, including old and new European Union (EU) member states and non-EU member states.

MATERIALS AND METHODS

Study population

The ESCMID Membership Directory (n = > 2500 entries) was used as the sampling frame for hospital recruitment; a recruitment flyer and initial screening questionnaire were circulated in 2002. In total, 263 European hospitals expressed an interest in participating. Data concerning hospital characteristics, including hospital size, case-mix, annual admissions and teaching status were obtained. These characteristics were compared with WHO and EU hospital datasets in an attempt to assess the representativeness and generalisability of the eventual recruited ARPAC sample.

Questionnaire survey

In 2003–2004, a series of questionnaires was sent to 263 registered ARPAC participants to collect retrospective hospital data for the year 2001 concerning: (a) antimicrobial susceptibility testing methods and antibiotic resistance rates; (b) antibiotic prescribing policies and antibiotic consumption data; (c) IC policies and practices; and (d) methods used for surveillance and control of selected antimicrobial-resistant pathogens with transmission potential, termed 'alert' organisms. This report is based on the results from questionnaire (c), which was completed by a qualified physician responsible for hospital IC or another delegated individual.

The IC questionnaire was developed in English by the ARPAC Steering Group and was piloted twice on a subsample of ten acute-care hospitals in different countries. Data relating to 2001 were collected concerning the following items: infection control management and organisation (11 questions); standard IC precautions for clinical staff (13 questions); audit and feedback on IC policies (seven questions); education programme (six questions); and IC staffing level (five questions). Following design modifications, the final version was mailed to participants in early 2003. Questionnaires were returned, either by mail or by Fax, by the deadline of 30 September 2003.

Statistical analysis

Data were entered into Microsoft Access 2000, and an independent validation check was made on a 10% sample. Statistical analysis was conducted using Epi-Info v.6 software (CDC, Atlanta, GA, USA). Descriptive analysis was conducted to identify associations between key IC factors and geographical/hospital factors, including hospital size, teaching status and case-mix variables, with $p < 0.01$ considered to be statistically significant. Data were analysed by European region using a modified standard European reference system [4], with hospitals from the UK categorised as part of western rather than northern Europe (Table 1). Assessment of regional representativeness was estimated using 2001 European bed data from EUROSTAT (http://www.euro.who.int). Hospital size was categorised as small (< 500 beds), medium (500–1000) or large (> 1000 beds). Descriptive statistics were conducted using medians and inter-quartile range (IQR), and statistical testing was conducted using non-parametric, Mann–Whitney U and Kruskal–Wallis tests.

IC policy score

An IC policy score was developed *a priori*, based on a weighting system from previous validation projects (HARMONY; http://www.hospitalhealthcare.com). Criteria contributing to the scoring system included: number of departments represented in the Infection Control Committee (ICC); full-time equivalent (FTE) infection control nurses (ICNs)/beds; FTE infection control doctors (ICDs)/beds; training of IC staff; surveillance programme; specific precautions for alert organisms; and standard IC precautions (hand hygiene policy/audit/feedback). An IC scale of 0–20 was divided into no IC input (score 0), low (1–8), medium (9–15) or high IC input (16–20). Scores were explored by geographical region and hospital characteristics.

RESULTS

Hospital characteristics

Complete IC data were received from 169 (64%) of 263 participating hospitals in 32 European

Table 1. ARPAC hospitals providing infection control data by European region and country (n = 169)

European region	Country	No. hospitals (%)
North	Denmark	5
	Norway	3
	Sweden	4
	The Netherlands	7
	Region total	19 (11)
West	Austria	5
	Belgium	18
	France	6
	Germany	10
	Swizerland	5
	UK	11
	Region total	55 (33)
South-East	Bosnia-Herzegovina	2
	Croatia	6
	Macedonia	1
	Yugoslavia	4
	Region total	13 (8)
South	Greece	7
	Italy	9
	Malta	1
	Portugal	2
	Spain	8
	Israel	2
	Turkey	10
	Region total	39 (23)
Central-East	Bulgaria	7
	Czech Republic	3
	Hungary	7
	Poland	6
	Romania	2
	Russia	1
	Slovakia	5
	Slovenia	5
	Estonia	2
	Latvia	2
	Lithuania	3
	Region total	43 (25)

countries (Table 1). Responding hospitals (n = 169) were more likely than non-responding hospitals recruited to the ARPAC study (n = 94) to have teaching status (p 0.03), but there were no differences according to geographical region (p 0.47), hospital size (p 0.81), and presence or size of ICU (p 0.14). The majority of participating hospitals had teaching status and offered intensive care, medical and surgical services (Table 2). Hospital size was distributed evenly across geographical regions, with a median of 659 (IQR, 114, 1014) beds.

Table 2. ARPAC hospital characteristics (n = 169)

Characteristic		*n* (%)
Hospital size	< 500 beds	61 (37)
	500–1000 beds	59 (36)
	> 1000 beds	43 (26)
	Missing data	6 (4)
Teaching status	Teaching	130 (77)
	Non-teaching	33 (20)
	Missing data	6 (4)
Specialised care	ICU beds	158 (94)
	Medical beds	149 (88)
	Surgical beds	156 (92)
	Paediatric beds	121 (72)

IC committee

The majority (n = 152; 90%) of hospitals had an IC Committee with multidisciplinary participation from clinical microbiology and infectious disease departments, clinical departments, ICNs, hospital epidemiology/ICDs, pharmacy, the hospital's Chief Executive and others (Table 3). There were significant regional differences in the composition of the committee: hospitals from central-eastern Europe were less likely to have participation from IC staff compared with hospitals in northern and western Europe, whereas infectious disease specialists were more likely to participate in committees from southern and south-eastern Europe ($p < 0.01$).

IC staff

In total, 134 (79%) hospitals reported ICNs who had received specific training in IC. There were regional differences, with hospitals in southern and south-eastern Europe being less likely to have trained ICNs compared with other regions (Table 4). The majority of hospitals (n = 120; 71%) reported an ICD with specific IC training; a similar geographical trend in distribution of hospitals with ICDs was noted (Table 4).

The median ICN-to-bed ratio was 2.33 ICNs/1000 beds (IQR 1.57, 3.48). Only 27/145 (18%) of evaluable hospitals reported more than one ICN for 250 beds. Nine hospitals reported having no ICNs, and 15 (9%) failed to provide data. There were only minor variations in ICN staffing levels among geographical regions. The median ICD-to-bed ratio was 0.94 ICDs/1000 beds (IQR 0.40, 1.69). The presence of at least one ICD/1000 beds was reported by 67 (40%) healthcare facilities, with only 15/147 (10%) of evaluable hospitals having more than one ICD/250 beds. A total of 25 (15%) hospitals reported having no ICD, and 17 (10%) hospitals failed to provide data. Fig. 1 displays median ICN and ICD numbers/250 beds according to training status and geographical region.

Link nurses

A link nurse, defined as a nurse working on the ward who liaises with the IC team on a regular basis, was reported by 77 (46%) of participating hospitals. In 47 (28%) hospitals, the link nurse

Table 3. Composition of the Infection Control Committee in ARPAC hospitals, grouped according to European region

Representation	North *n* = 19 (%)	West *n* = 55 (%)	South *n* = 39 (%)	South-east *n* = 13 (%)	Central-east *n* = 43 (%)	All regions *n* = 169 (%)
Medical microbiology	17 (90)	48 (87)	36 (92)	12 (92)	34 (79)	147 (87)
Clinical department	15 (79)	46 (84)	33 (85)	11 (85)	30 (70)	135 (80)
IC nurse	14 (74[a])	50 (91[a])	35 (90[a])	10 (77[a])	18 (42 [a])	127 (75)
IC doctor	12 (63[a])	50 (91[a])	18 (46[a])	7 (54*)	21 (49 [a])	108 (64)
Pharmacy	9 (47[a])	36 (66[a])	31 (80[a])	4 (31 [a])	21 (49 [a])	104 (62)
Chief Executive	9 (47[a])	36 (66[a])	30 (77[a])	8 (62[a])	16 (37 [a])	99 (59)
Infectious diseases	11 (58[a])	26 (47[a])	31 (80[a])	10 (77[a])	17 (40 [a])	95 (56)
Hospital epidemiology	5 (26[a])	20 (36[a])	8 (21[a])	10 (77*)	11 (26 [a])	54 (32)
Maintenance	6 (32[a])	29 (53[a])	10 (26[a])	0 (0)	6 (14 [a])	51 (30)
Occupational health	10 (53[a])	31 (56)	6 (15)	2 (15)	0 (0)	49 (29)
Public health doctor	2 (11)	13 (24)	5 (13)	1 (8)	3 (7)	24 (14)

[a]p 0.01, chi-square test. IC, infection control.

Table 4. Proportion of ARPAC hospitals reporting the presence of trained infection control nurses (ICNs) and infection control doctors (ICDs) during 2001

		Trained ICNs *n* = 134 (%)	Trained ICDs *n* = 120 (%)
Geographical region			
	North	17 (90[a])	14 (74[a])
	West	55 (100[a])	46 (84[a])
	South	32 (82[a])	27 (69[a])
	South-east	7 (54[a])	6 (46[a])
	Central-east	23 (54[a])	27 (63[a])
Teaching status			
	Teaching	100 (77)	94 (72)
	Non-teaching	28 (85)	23 (70)
Hospital size			
	Small	43 (71)	36 (59)
	Medium	51 (86)	46 (78)
	Large	35 (81)	34 (79)

[a]p 0.01, chi-square test.

system was deployed for the entire hospital. There was no significant geographical variation in the implementation of this system (p > 0.01).

IC programme

The existence of an IC programme with annual objectives and progress reports was reported by 122 (72%) hospitals. In approximately two-thirds of hospitals (116; 69%), senior management received and/or reviewed the IC annual report. Over half of participating hospitals (98; 58%) reported that senior management were ultimately responsible for delivery of the IC programme. There was no significant variation according to region, size or teaching status for any aspect of the IC programmes.

Standard IC precautions

Written guidelines for standard precautions taken by healthcare workers were available in 127 (75%) of hospitals during 2001. Components of these

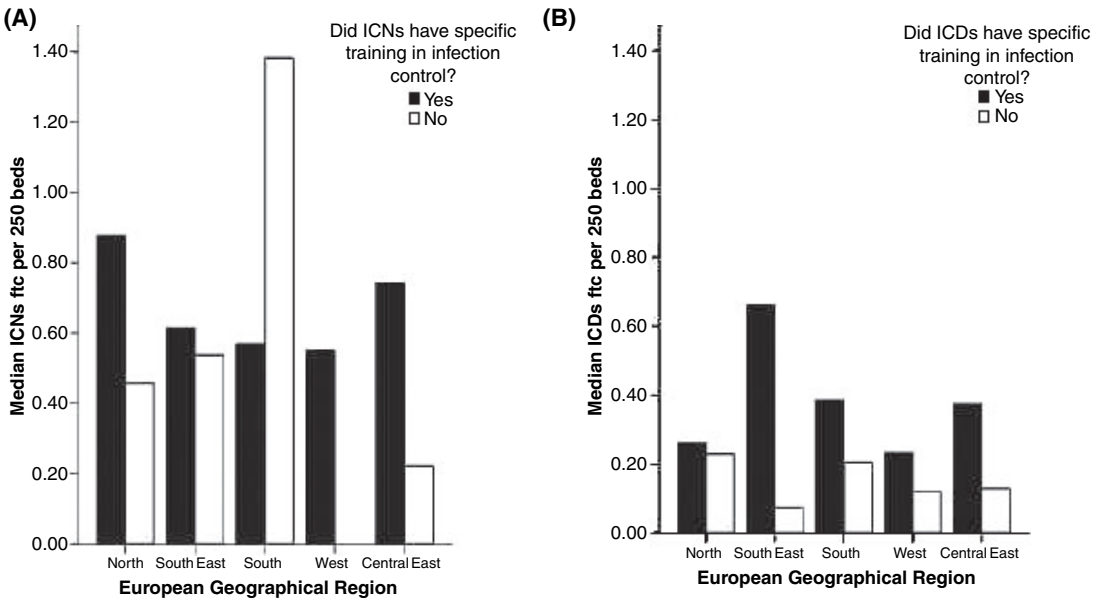

Fig. 1. (A) Median full-time equivalent (FTE) infection control nurses (ICNs)/250 beds, with and without special infection control training, grouped according to European geographical region. (B) Median infection control doctors (ICDs)/250 beds, with and without special infection control training, grouped according to European geographical region.

Table 5. Products recommended to healthcare staff for hand hygiene, grouped according to European region

Recommended product	North $n = 19$	West $n = 55$	South $n = 39$	SE $n = 13$	CE $n = 43$	All regions $n = 169$ (%)[a]
Plain soap	11 (58[b])	16 (29[b])	15 (39[b])	8 (62[b])	14 (33[b])	64 (38)
Medicated/antiseptic soap	2 (11[c])	12 (22[c])	30 (77[c])	8 (62[c])	21 (49[c])	73 (43)
Alcohol-based solutions for non-soiled hands	19 (100[c])	39 (71[c])	16 (41[c])	9 (69[c])	35 (81[c])	118 (70)
Alcohol-based gel/foam for non-soiled hands	4 (21[b])	14 (26[b])	1 (3[b])	0 (0[b])	10 (26[b])	29 (17)
No recommendation	0 (0)	1 (2)	0 (0)	0 (0)	1 (2)	2 (1)

[a]Total answering 'yes' to recommended product.
[b]$p < 0.05$; [c]$p < 0.01$, chi-square test.
SE, South-east; CE, Central-east.

policies for hand hygiene procedures showed significant differences among regions (Table 5): alcohol-based solutions for non-soiled hands were recommended mainly by hospitals in northern, western and central-eastern Europe; medicated/antiseptic and plain soap were recommended more frequently in southern Europe; and all products were recommended frequently in south-eastern Europe.

More than 88% of hospitals recommended that healthcare workers should wear gloves for all contact with blood, body fluids and mucous membranes. A lower proportion of hospitals (124; 73%) recommended wearing gloves for contact with non-intact skin, with significant regional variation; hospitals in northern and western Europe were more likely to recommend gloves than those in central-eastern Europe ($p < 0.01$). Policies also recommended that healthcare workers wash or disinfect hands after removing gloves (152; 90%), with a similar frequency according to region, hospital size and teaching status.

Hospitals were asked to report how often hand hygiene policies were updated: approximately one-third of hospitals (51; 30%) reported that policies had been updated during the previous 3 years; 34 (20%) reported updates during the past 3–5 years; and 26 (15%) reported longer time intervals (58 (34%) missing responses). There were no differences in frequency of policy revision according to region, size or teaching status.

A variety of educational, logistical and communication methods were used to promote hand hygiene, with significant regional variations (Table 6). In particular, logistical support in terms of providing hand hygiene products at the bedside and facilitating the skin care of healthcare workers was reported more frequently in hospitals in northern and western Europe. There were no differences in the methods used according to hospital size or teaching status.

IC procedures

Most hospitals reported having written protocols for IC procedures concerning: (a) basic IC (117; 70%); (b) room cleaning (120; 71%); (c) screening for multiresistant organisms (90; 53%); and (d) isolation of patients with alert organisms (106; 63%). There was significant geographical variation with respect to the presence of protocols (except for alert organism screening), with higher frequencies in northern and western Europe compared with south-eastern and central-eastern Europe ($p < 0.01$).

Surveillance and feedback

Surveillance of nosocomial infections and alert organisms was performed by 125 (74%) and 124 (73%) centres, respectively, with no significant regional differences. However, only 64 (38%)

Table 6. Methods used to promote hand hygiene among hospital staff, grouped according to European region

Method	North $n = 19$	West $n = 55$	South $n = 39$	SE $n = 13$	CE $n = 43$	All regions $n = 169$ (%)
HCW education/in-service training	18 (95[a])	50 (91[a])	32 (82[a])	9 (69[a])	33 (77[a])	142 (84)
Routine observation/feedback on compliance	2 (11[a])	30 (55[a])	17 (44[a])	7 (54[a])	22 (52[a])	78 (46)
HH products available by patient bedside	16 (84[a])	44 (80[a])	22 (56[a])	5 (39[a])	21 (49[a])	108 (64)
Reminders in work places or posters	9 (47)	41 (75)	24 (62)	9 (69)	26 (61)	109 (65)
Rewards for good performance	0 (0)	2 (2)	3 (7)	2 (15)	1 (2)	8 (5)
Administrative sanction for poor performance	0 (0)	0 (0)	2 (5)	1 (8)	6 (14)	9 (5)
Promotion/facilitating HCW's skin care	10 (53[a])	26 (47[a])	9 (23[a])	4 (31)	9 (1[a])	58 (34)
Written guidelines	15 (79[a])	49 (89[a])	28 (72[a])	9 (69[a])	28 (65[a])	129 (76)
Encouragement from key staff/clinical leaders	6 (32)	25 (6)	16 (41)	3 (23)	11 (26)	61 (36)
Targeting groups with poor compliance	1 (5)	10 (18)	6 (15)	1 (8)	3 (7)	21 (12)

[a]p 0.01, chi-square test; column percentages presented.
HCW, healthcare worker; HH, hand hygiene; SE, South-east; CE, Central-east.

hospitals produced epidemiology reports during 2001 concerning the prevalence of patients colonised or infected with alert organisms, and only 40 (24%) hospitals presented such reports to clinical staff with data broken down by department. In two-thirds of hospitals (112; 66%), the IC team provided regular activity reports to the IC committee. Hospitals in northern and western Europe were more likely to provide these reports than institutions in south-eastern and central-eastern Europe ($p < 0.01$).

Education

Educational sessions for healthcare workers concerning IC practices were reported by 131 (77%) centres. These targeted mainly qualified nurses (71%), junior medical staff (51%), cleaning staff (52%), unqualified nursing assistants (51%), medical students (39%) and link nurses (38%), with higher frequencies found in northern and western Europe than in south-eastern and central-eastern Europe ($p < 0.01$). Attendance at these educational sessions was generally not recorded, either for doctors (89%) or nurses (72%). Feedback of audit data in educational sessions was infrequent (29%). Only 91 (54%) participants included IC policies in the programme of induction training for clinical staff.

IC scoring

IC policy scores (range, 0–20) were calculated for each healthcare institution (missing data for 12 hospitals). The median IC score was 9.0 (IQR 7, 11). The intensity of IC programmes appeared higher in northern and western Europe than in other regions, although this difference did not achieve statistical significance (Table 7). There were no differences in scores according to teaching status or hospital size.

Table 7. Level of infection control input according to European region

IC score for level of input	North $n = 19$ (%)	West $n = 55$ (%)	South $n = 39$ (%)	SE $n = 13$ (%)	CE $n = 43$ (%)	All regions $n = 169$ (%)
Low (1–8)	5 (29[a])	4 (7[a])	6 (16[a])	4 (40[a])	9 (22[a])	28 (17)
Medium (9–15)	6 (35[a])	33 (64[a])	26 (70[a])	6 (60[a])	27 (66[a])	98 (58)
High (16–20)	6 (35[a])	15 (29[a])	5 (14[a])	0 (0[a])	5 (12[a])	31 (18)

[a]p 0.02, chi-square test; 12 (7%) hospitals had missing data.
SE, South-East; CE, Central-East.

Implementation problems

Problems in implementing IC policies during 2001 were reported by the majority of hospitals, and included: (a) an insufficient number of isolation rooms (142; 84%), which was an occasional problem for most hospitals in northern and western Europe and a permanent problem for most hospitals in central-eastern Europe; (b) non-compliance with hand hygiene procedures (132; 78%), which appeared to be a problem in all regions; (c) a lack of skilled staff (117; 69%), which was an occasional problem for most hospitals in southern and western Europe, and a permanent problem for most hospitals in south-eastern Europe; and (d) poor compliance with procedures for decontaminating the environment in patients' rooms (66; 39%).

DISCUSSION

This is the largest survey conducted to date to ascertain current organisation, resources and policies for IC in European hospitals. Major deficiencies were observed, despite the fact that the self-selected sample in this survey was biased towards large academic centres with, presumably, better than average resources [5]. Some key elements of well-organised IC programmes were generally evident, such as guidance by a multidisciplinary prevention and control-of-infection committee, management support and an annual activity programme, including surveillance of nosocomial infection and staff training [6,7]. In contrast, audit of procedures and feedback of surveillance data were uncommon practices, and trained IC staffing resources were below recommended standards in the majority of hospitals [6–8]. The use of alcohol-based hand rubs, which is the current standard for routine hand hygiene, was not included within the IC policy in one-third of hospitals. Hand hygiene promotion programmes were incomplete and marked regional variations were found. Resource deficit and sub-standard policies were more frequent in hospitals in south-eastern and central-eastern Europe than in northern and western Europe. These findings have important policy implications at the local, national and European levels in terms of promoting patient safety and containing antimicrobial resistance in the acute-care setting.

There are several methodological aspects of this study that deserve comment. First, this survey was unique in its geographical breadth, in that it encompassed 32 countries across Europe, located both within and outside the EU, and included a large sample of hospitals. Data collection was performed using validated definitions to improve consistency, with international reporting from diverse healthcare systems. Data collection tools were developed by an experienced international group of clinical scientists from complementary disciplines. These tools were piloted by hospital practitioners from different European regions to test their feasibility, clarity and potential for measurement error. It should also be emphasised that data analysis used a conservative statistical cut-off point to adjust for multiple hypothesis testing.

However, the study also has limitations, and some findings should be interpreted with caution. The hospitals were self-selecting, which increases the risk for selection and response bias, and may not entirely reflect variation in IC policies throughout Europe. In particular, there was an over-representation of teaching hospitals in the study. Ideally, a full listing of all acute-care hospitals in Europe would provide a sampling frame for random selection of eligible hospitals, but no such list exists, and therefore alternative approaches were used for hospital recruitment. The use of specialist membership lists is a recognised method for sampling in research studies, although this method does not ensure that all members of the target population are covered [5]. Country-level hospital data, particularly numbers of acute-care beds, were obtained from EUROSTAT (http://www.euro.who.int) for comparative purposes; however, the classification and definition of 'acute-care' beds varies among countries. The crude estimated coverage of beds in the ARPAC study was 10% or less per region, but for many countries, the EUROSTAT denominator value included psychiatric, long-stay and community beds. The actual coverage per region is therefore probably higher than the value estimated above. However, variation in response rates by country or region may have compromised the regional representativeness of participating hospitals. There was potential for recall bias, as questionnaires asking about policies for 2001 were distributed in early 2003. A final consideration relates to the questionnaire design, since it collected self-reported policies, which should not be misrepresented as measuring actual behaviour. Thus, it should be emphasised that this report provides a picture of IC policies that is likely to overestimate the intensity of practices in European hospitals during 2001.

Effectively reducing the risk of healthcare-associated infection and the spread of antibiotic-resistant pathogens depends critically on professional IC services. In the 1970s, the SENIC study [6] identified the first evidence-based structural components of effective IC programmes: the availability of a physician with specific training in hospital epidemiology and IC, also referred to as an infection control doctor (ICD); a minimum of one full-time IC practitioner, who often has a nursing background and is therefore referred to as an infection control nurse (ICN), per 250 occupied acute-care beds; a hospital-wide continuous surveillance system for nosocomial infection; and feedback of surveillance data to the relevant healthcare workers and a structured prevention plan. More recently, these requirements have been revised and refined, based on expert opinion, to propose more cost-effective approaches for surveillance and to take into account the increasingly complex delivery of hospital and ambulatory care, increased turnover, increased severity of illness in the hospitalised patient population, and epidemic spread of antibiotic-resistant pathogens. In 1998, professional organisations in the USA and the CDC published consensus guidelines that defined the key functions of effective IC programmes: targeted surveillance of nosocomial infection; detection and control of outbreaks; setting, implementing and auditing written policies for IC; and education and training of healthcare workers [7]. These guidelines also stated that IC personnel should be recruited in proportion to the estimated risk for the population served by the institution. Canadian IC experts developed a model to quantify the staffing needs for effective IC programmes, and suggested that general hospitals would require one full-time ICN/167 acute-care beds [8]. A panel of experts from ESGNI reported that the average 2004 national standards among 12 European countries were 1.2 ICDs and 3.4 ICNs/1000 beds, respectively, whereas estimated requirements were higher at 1.8 ICDs and 4.2 ICNs/1000 beds, respectively, with an additional 3.3

co-workers/1000 beds for data management and administrative support [9].

In the present survey, 90% of hospitals had a multidisciplinary IC committee in operation, and more than two-thirds had annual action plans and hospital management support. Three-quarters of hospitals in the ARPAC study conducted a surveillance programme for nosocomial infections and antibiotic resistance. These findings are less impressive than those in Canada, where 92% and 94% of hospitals operated surveillance systems in 2000 for nosocomial infection and methicillin-resistant *Staphylococcus aureus* infection rates, respectively. According to current guidelines, most European hospitals in the ARPAC study had grossly insufficient resources in terms of ICNs and ICDs. Only 17% of facilities had at least one ICN/250 beds, as recommended in SENIC, with a median of one ICN/430 beds. These staffing levels appear better than the median ICN-to-bed ratio of 1/503 and 1/617 reported 5 years earlier in western and eastern European hospitals, respectively [10], but this staffing ratio is low compared with the figure of 58% of Canadian hospitals that met this SENIC recommendation, with a median of one ICN/244 beds in 2000 [11]. ICD staffing appeared better in the present survey, which suggested that 71% of hospitals in the ARPAC study had specially trained physicians (MDs), compared with 14% of US hospitals in 1996 and 60% of Canadian hospitals in 2000 that had an MD or scientist (PhD) with IC training [11,12]. However, IC training is not formally certified as a medical specialty in most countries, and may vary substantially in content and expertise [9]. This training deficiency has been addressed by ESCMID, which published recommendations for national IC training programmes for infection specialists and provides international training courses in hospital epidemiology [9,13].

Compliance with standard precautions, including efficient hand hygiene techniques and barrier measures, is the cornerstone for prevention of cross-infection by healthcare providers [14–16]. The ARPAC study clearly identified efforts by the vast majority of European IC programmes, especially in northern and western Europe, to establish guidelines and train healthcare staff in these procedures. Current guidelines recommend the use of alcohol-based hand rubs as the standard of care for decontaminating non-soiled hands [15]. In 2001, this was part of the local policy in 70% of European hospitals, but with marked regional differences. The use of medicated soap was still recommended in a majority of hospitals in southern Europe, despite the numerous disadvantages of these products. Methods used for promoting adherence to hand hygiene also varied significantly according to region, with a stronger emphasis in northern and western Europe on making antiseptics available at the bedside and promoting the skin care of healthcare workers, two factors that have proved crucial for improving compliance [15]. A majority (78%) of ARPAC hospitals reported encountering the problem of insufficient compliance with hand hygiene. Strategies to improve hand hygiene compliance must include staff education and motivation, the use of performance indicators, and hospital management support [15]. It is therefore important to address the deficiencies apparent in the majority of programmes described in the ARPAC participating hospitals, which fail to train many categories of healthcare workers and lack audit of compliance, as well as feedback of audit and surveillance results in educational sessions.

The findings of the present study have important implications for future patient safety, staff behaviour, health policy and research. At a Consensus Conference held in Amsterdam, The Netherlands, in November 2004, ARPAC data were discussed, and consensus recommendations were developed [16]. Within the scope of IC organisation and implementation, the following priorities for national authorities and hospital management were identified: urgent action should be taken to remove barriers, e.g., the lack of sufficient numbers of skilled healthcare personnel and isolation facilities; certified training in IC should be established; and urgent action should be taken to ensure that acute-care hospitals have adequate IC staffing levels, with the SENIC study recommendations as a minimum [16]. In an enlarging EU, where major deficiencies in hospital infection programmes are more pronounced in less affluent countries, political commitment to improve patient safety and contain antimicrobial resistance should translate into stronger cooperation between countries. Developing the evidence base for prevention policies and sharing of best practice should be conducted in partnership among

professional organisations, governments and EU agencies [16].

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