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A national point prevalence study on healthcare-associated infections and antimicrobial use in Austria

Luigi Segagni Lusignani · Alexander Blacky · Peter Starzengruber · Magda Diab-Elschahawi · Thomas Wrba · Elisabeth Presterl

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Summary
Background The first point prevalence survey performed in Austria had the aim to assess the magnitude of healthcare-associated infections and antimicrobials use in the country.

Methods A multicentre study was carried out from May until June 2012 in nine acute care hospitals with a mean bed number of 620. Data from 4321 patients' clinical charts were reviewed.

Results The overall healthcare-associated infections prevalence was 6.2 % (268/4321) with the highest rate in intensive care departments (20.9 %; 49/234). In medical and surgical departments the healthcare-associated infections prevalence was 5.4 % (95/1745) and 6.6 % (105/1586), respectively. The most frequent healthcare-associated infections were: urinary tract infections (21.3 %; 61/287), pneumonia (20.6 %; 59/287) and surgical site infections (17.4 %; 50/287). The most common isolated microorganisms were: *Escherichia coli* (14.8 %; 26/176), *Enterococcus species* (13.1 %; 23/176) and *Pseudomonas aeruginosa* (11.4 %; 20/176). Thirty-three per cent (1425/4321) of the patients received antimicrobials because of community-acquired infections treatment (14.2 %; 615/4321), healthcare-associated infections treatment (6.4 %; 278/4321), and surgical (8.2 %; 354/4321) and medical prophylaxis (3.2 %; 138/4321). Surgical prophylaxis was the indication for 22.0 % (394/1792) of the overall prescriptions and was prolonged for more than 1 day in 77.2 % (304/394) of the cases.

Conclusion The national Austrian survey proved the feasibility of a nation-wide network of surveillance of both healthcare-associated infections and antimicrobial use that will be repeated in the future. Healthcare-associated infections and antimicrobial use have been confirmed to be a grave health problem. The excessive prolongation of perioperative prophylaxis in Austria needs to be limited.

Keywords Point prevalence · Healthcare-associated infections · Antimicrobials · Acute care hospitals · Surveillance

Ass. Prof. M. Diab-Elschahawi, MD, Msc (✉) ·
Dr. L. Segagni Lusignani · Dr. P. Starzengruber · Prof. E. Presterl
Department of Hospital Epidemiology and Infection Control,
Vienna General Hospital, Medical University of Vienna,
Währinger Gürtel 18–20,
1090 Vienna, Austria
e-mail: magda.diab-elschahawi@meduniwien.ac.at

Dr. A. Blacky
VAMED Hospital Management, Sterilization and Disinfection,
Vienna, Austria

Dipl. Ing. T. Wrba
Center for Medical Statistics, Informatics and Intelligent Systems,
Medical University of Vienna,
Vienna, Austria

Introduction

The impact of healthcare-associated infections (HAI) implies prolonged hospital stay, long-term disability and increased resistance of microorganisms to antimicrobials. According to the available evidence, approximately 4 million patients acquire at least one HAI in Europe every year; HAI cause 16 million extra days of hospital stay and 37,000 attributable deaths, contributing to an additional 110,000 every year. The burden of disease is also reflected in important annual financial losses estimated at approximately € 7 billion, including only direct costs [1].

Published evidence suggests that at least 20–30 % of HAI are avoidable, and infection prevention and control strategies provide cost-effective solutions [2–4].

However, overuse of antimicrobial drugs is associated with drug resistance and undermines public health efforts considerably [5, 6].

Comparisons between international and national data on HAI magnitude and pattern of antimicrobial use (AMU) in hospital settings are often problematic or not feasible because national databases include data collected with different methodologies.

In 2012, the Department of Infection Control and Hospital Epidemiology of the Medical University of Vienna implemented the first HAI and AMU point prevalence survey in Austria. This project was supervised by the European Centre for Disease Prevention and Control (ECDC) through a standardized protocol within 947 participating hospitals of 30 European Union (EU) member states.

The objectives of the current study in Austria were: to assess the burden of HAI and AMU in Austrian acute care hospitals, to provide a standardized HAI and AMU surveillance tool and to reinforce national surveillance capacity.

Methods

The survey data collection took place between May and June 2012. Nine acute care hospitals took part in the study on a voluntary basis. The Austrian protocol was developed based upon the ECDC protocol [7], and the ECDC case definitions list was translated into German with no modifications. Hospital data collectors were trained between January and April 2012 by the national coordinators in order to become familiar with the survey tools. All acute care unit patients admitted to the ward before 8:00 a.m. and not discharged at the time of the survey were included. Long-term care units, dialysis and emergency rooms and outpatient departments were excluded. Data collection on ward was completed within a single day using two forms: the "hospital data form", providing details regarding the structure of the hospital and process indicators (i.e. infection control staff availability, alcohol rub consumption, single-room beds) of the surveyed hospital; the "patient data form", including demographic and clinical data, severity of the underlying medical condition according to McCabe prognostic criteria (non-fatal, ultimately fatal, rapidly fatal) [8], any prescribed antimicrobials and active HAI at the time of the survey, if present. Data on the prevalence of microorganisms that constitute a serious threat to public health and their resistance to specific antimicrobials were also collected. Hospitals' data collectors searched information on inpatients from all relevant sources including clinical notes and prescriptions, results of examinations, temperature charts and, when necessary, through discussion with the ward staff. Microbiological confirmation was not required for each HAI definition. The HAI case definitions of the Hospital Europe Link for Infection Control through Surveillance (HELICS) were adopted [9, 10]. For the AMU documentation the Anatomical Therapeutic Chemical (ATC) classification of the World Health Organization was used [11]. The Austrian data were sent to the Department of Infection Control and Hospital Epidemiology of Vienna, inserted in a databank and analysed. Data on AMU were collected if the patient was receiving antimicrobials for treatment or medical prophylaxis at the time of survey and/or had received at least one dose of surgical prophylaxis prior to 8:00 a.m. on the day of the survey. Antifungal treatment was included in this survey. Tuberculosis and antiviral treatments were excluded from the survey.

Results

The nine participating Austrian hospitals represented 4.7 % (9/189) of the national acute care hospitals. Of these, 45 % (4/9) had fewer than 200 beds, 11 % (1/9) between 200 and 399, 11 % (1/9) between 400 and 600 and 33 % (3/9) more than 600. The mean hospital bed number was 450 (confidence interval (CI): 115.6–595.7). Medical and surgery units represented two third (3331 patients) of the total wards. In these hospitals, the hand rub consumption was 27 l per 1000 patient days; the number of single-room beds (as percentage of the total number of beds) varied from 5 to 10 %. In all nine Austrian hospitals, a full-time (40 h per week) infection prevention and control nurse per 250 beds was present. Patients' demographic and clinic characteristics are listed in Table 1. Out of the 4321 patients, 268 had at least one HAI, which means a total HAI prevalence of 6.2 % (95 %, CI: 4.2–9.1). Of the

Table 1 Demographic and clinical characteristics of the Austrian patients

Patient characteristics	Patients (*n*)	Patients (%)	Patients with HAI	HAI (%)
Males	2010	46.5	127	6.3
Females	2311	53.5	141	6.1
< 1 year	152	3.5	5	3.3
1–44 years	908	21.0	33	3.6
≥ 45 years	3261	75.5	230	7.1
LOS 1–3 days	1316	30.5	24	1.8
LOS 4–7 days	1094	25.3	59	5.4
LOS 8–14 days	934	21.6	73	7.8
LOS ≥ 15days	974	22.5	111	11.4
LOS unknown	3	0.1	1	33.3
MCS non-fatal	2997	69.4	100	3.3
MCS ultimately fatal	913	21.1	113	12.4
MCS rapidly fatal	246	5.7	35	14.2
MCS unknown	165	3.8	20	12.1
Surgery since admission	1414	32.7	138	9.8
Central vascular catheter	548	12.7	114	20.8
Peripheral vascular catheter	2097	48.5	140	6.7
Urinary catheter	749	17.3	106	14.2
Intubation	91	2.1	24	26.4

HAI healthcare-associated infections, *LOS* length of stay, *MCS* McCabe score

Table 2 Healthcare-associated infections (HAI) and antimicrobial use (AMU) prevalence in Austria, by speciality

Department	Patient (*n*)	Patients with HAI (%)	Patients with AMU (%)
Surgery	1586	105 (6.6)	618 (39.0)
Medicine	1745	95 (5.4)	512 (29.3)
Gynaecology/obstetrics	341	5 (1.5)	79 (23.2)
Intensive care units	234	49 (20.9)	159 (67.9)
Paediatrics	92	0 (0.0)	8 (8.7)
Psychiatry	147	2 (1.4)	4 (2.7)
Other	176	12 (6.8)	45 (25.6)
Total	4321	268 (6.2)	1.425 (33.0)

Table 3 Prevalence of healthcare-associated infections (HAI) in Austria and the European Union (EU), by infection

HAI type	Austria		EU	
	n	%	*n*	%
Urinary tract infections	61	21.3	2848	19.0
Pneumonia	59	20.6	2907	19.4
Surgical site infections	50	17.4	2941	19.6
Gastro-intestinal infections	30	10.5	1134	7.6
Systemic infections	26	9.1	934	6.2
Bloodstream infections	22	7.7	1585	10.6
Catheter-related infections	18	6.3	233	1.6
Skin and soft tissue infections	11	3.8	599	4.0
Eye, ear, nose or mouth infections	3	1.0	454	3.0
Bone and joint infections	3	1.0	245	1.6
Other low respiratory tract infections	2	0.7	609	4.1
Cardiovascular system infections	1	0.3	204	1.4
Reproductive tract infections	1	0.3	87	0.6
Central nervous system infections	0	0.0	97	0.6
Other HAI	0	0.0	123	0.8
Total	287	100.0	15,000	100.0

287 confirmed HAI, 35 (12.2%) were already present on admission, and 28 (9.7%) originated from a healthcare institution other than the study hospitals. HAI prevalence was higher in intensive care units (ICU; Table 2) where 18.3% (49/268) of all HAI patients were detected. Urinary tract infections, pneumonia and surgical site infections represented the most common type of HAI (Table 3). More than half of the gastrointestinal infections were *Clostridium difficile* infections (CDI; 17/287). HAI prevalence was significantly higher in patients with a hospital stay longer than 3 days (c^2-test: 132.5; $p<0.001$) and in patients with McCabe prognostic score "ultimately" or "rapidly fatal" (c^2-test: 62.0; $p<0.001$). A total of 135 (47%) of the 287 HAI had 176 microorganisms identified. Out of the most frequently reported organisms responsible for HAI (Fig. 1), 14.8% (26/176) were *Escherichia coli*, followed by *Enterococcus* with 13.1% (23/176) and *Pseudomonas aeruginosa* with 11.4% (20/176). Selected antimicrobial susceptibility testing (AST) data were available

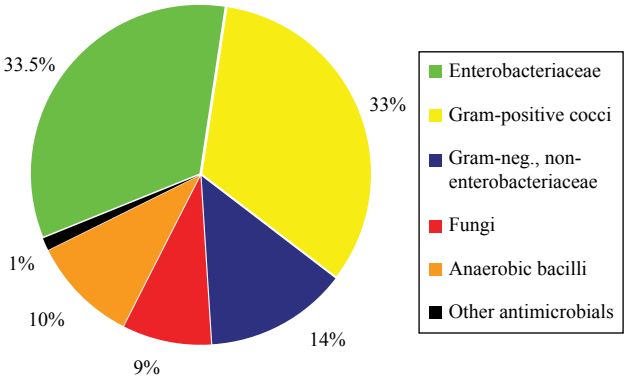

Fig. 1 Most frequently identified microorganisms responsible for healthcare-associated infections (HAI) in Austria

on the day of the survey for 87.0% of the 176 microorganisms reported for HAI. Out of these, only 21 were classified as multiresistant bacteria; meticillin resistance was reported in 53.8% (7/13) of *Staphylococcus aureus* isolates; non-susceptibility to third-generation cephalosporins was reported in 30.4% (7/23) of *E. coli*, in 18.2% (2/11) of *Klebsiella species* and in 12.5% (1/8) of *Enterobacter species* isolates. Non-susceptibility to carbapenems was found in 10.5% (2/19) of *P. aeruginosa* and in 8.7% (2/23) of *E. coli isolates*.

The total number of antimicrobials prescribed in the survey was 1792, and 1425 out of 4321 patients (33%; 95% CI: 28.9–37.4) were prescribed one or more antimicrobials, which equates to 1.26 per patient prescribed antimicrobials. Antimicrobials were administered parenterally in 72.7% (1302/1792) of cases and the reason for their use was documented in the medical notes in 68.8% (1233/1792) of cases. The prevalence of AMU was the highest in ICU and the lowest in psychiatric departments (Table 2). Overall 14.2% (615) of patients received antimicrobials because of community infections, 8.2% (354) for surgical prophylaxis, 6.4% (278) for hospital infections, 3.2% (138) for medical prophylaxis and 0.3% (13) for long-term care infections. Of the 394 antimicrobials used for surgical prophylaxis, only 61 (15.4%) were administered in single dose, while 29 (7.4%) for 1 day and 304 (77.2%) for more than 1 day. Perioperative prophylaxis accounted for 22% (394/1792) of total AMU and was significantly higher than other EU member states' rate (c^2-test: 71.5; $p<0.001$). The majority of hospital infections' AMU was for respiratory tract infections (69/296; 23%). The most common reason for community-acquired infections' AMU was skin and soft tissue infections (159/622; 26%), followed by respiratory tract infections (147/622; 24%;). Out of the 1792 antimicrobials, 368 (20.5%) were aminopenicillins and β-lactamase inhibitors, 265 (14.8%) quinolones, 221 (12.8%) first- and second-generation cephalosporins, 116 (6.5%) clindamycin, 115 (6.4%) piperacillin and enzyme inhibitors and 75 (4.2%) carbapenems. With regard to surgical prophylaxis, first-generation cephalosporins (95/394; 24.1%), aminopenicillins and β-lactamase inhibitors (88/394; 22.3%) and second-generation cephalosporins

(75/394; 19.0 %;) were the most frequently prescribed antimicrobials. The prevalence of AMU was significantly higher in patients with a hospital stay longer than 3 days (c^2-test: 31.6; $p < 0.001$). AMU prevalence was significantly higher in ultimately and rapidly fatal patients than in non-fatal patients (c^2-test: 62.2; $p < 0.001$). Around 61 % (336/548) of the patients with a central venous catheter and 80 % (72/91) of the intubated patients received antimicrobials.

Discussion

This was the first national prevalence survey collecting data on healthcare-acquired infections, AMU, infection control structure and process indicators conducted in Austria. The study, under the ECDC supervision and with the same standardized protocol, was simultaneously conducted in thirty EU member states, thus being the largest European point prevalence survey of AMU in acute care settings performed to date. Results from 947 European hospitals and 231,459 patients showed an overall HAI prevalence of 6.0 % (95 %, CI: 2.3– 10.8 %), an AMU prevalence of 35 % (country range 21.4–54.7 %) and confirmed that HAI are a major public health problem in Europe [12].

In the Austrian survey, 4321 patients of nine acute hospitals were included in the representative sample for analysis. At hospital hygiene structure and process indicators level, the Austrian hand rub consumption was significantly higher compared with the European mean (18.7 l per patient days) and the number of single-room beds was in mean with the European median (9.9 %). Even though the number of full-time infection prevention and control nurses fulfilled the Study on the Efficacy of Nosocomial Infection Control (SENIC) literature standards [13], an increased number of infection control personnel per bed, together with the implementation of infection control activities, could reduce both hospital infection rate and costs [14].

The HAI prevalence of 6.2 % observed in acute hospitals in Austria is in line with the European mean and seems to increase as age, length of hospital stay and comorbidity raise. As would be expected, a higher prevalence of HAI and AMU was observed in both Austrian and European ICU where invasive devices are more frequently used. The use of such devices is associated with higher risk of infections and worse patients' outcomes [15]. Respiratory tract infections were the most frequent HAI detected both in Austria and in Europe. Because in our study 33 % (20/60) of the patients with respiratory tract infections were intubated in the 48 h preceding the infection onset, introduction of ventilator-associated pneumonia surveillance could provide a more understanding picture and contribute to implement more targeted interventions to fight these high-cost infections [16]. Urinary tract infections occurred as often as respiratory tract infections in Austria and are the third most common HAI in Europe. In our national survey, 70 % (43/61) of patients with urinary tract infection had a urinary catheter in the preceding 7 days. This finding suggests that implementation of low-cost interventions, such as education and training on urinary catheter insertion technique, should be a hospital priority in order to curb these HAI [17]. The third most frequent hospital-acquired infection detected in Austria and the second in Europe was surgical site infection. Since 2004, an Austrian national surgical site infection surveillance system (ANISS) is in place [18], though on voluntary basis. A mandatory participation in all Austrian acute care hospitals in the future should be put in place in order to drive down this HAI.

In Austria, data on severe CDI incidence rates are limited and estimated as 16–18 % of all CDI cases [19, 20]; nevertheless, the striking high national prevalence of CDI detected in this survey was significantly higher than the average of other EU member states (c^2-test: 3.86; p value: 0.049). This should drive a firmer national effort in engaging with infection by strengthening hygiene prevention measures as well as a more rational antibiotic use policy. *Enterobacteriaceae* were the most common organism in relation with HAI detected both in Austria and in the EU; further work to control the presence and prevent potential transmission of third-generation cephalosporin-resistant *Enterobacteriaceae* both in Austrian and EU hospitals should therefore be encouraged. The high rate of carbapenem-resistant gram-negative bacteria in Europe (22.6 % of *Klebsiella pneumoniae*, 31.8 % of *P. aeruginosa*, 81.2 % of *Acinetobacter baumanii*) suggests that interventions designed to reduce the prevalence of HAI related to this group of microorganisms should be prioritized [12].

Results also showed an excessive use of broad-spectrum antimicrobials, frequent parenteral administration and that a significant area of antibacterial overuse in Austrian acute hospitals was surgical prophylaxis prolonged more than 1 day. However there is evidence that surgical prophylaxis should cover only the perioperative period and that irresponsible use of antibiotics is the main factor underlying the past decades' high rates of drug-resistant infections [21–24]. National health policies should aim soon to reduce the duration of prophylaxis longer than 24 h in all specialities. In addition, tight and continuous education of clinical staff could assure that more than 90 % of clinical notes include documentation of antibacterial indication.

This study has some limitations. Being cross-sectional studies, point prevalence surveys can both underestimate HAI burden and overestimate surgical prophylaxis. Voluntary participation could also lead to results' bias. Nevertheless, point prevalence surveys are more cost-effective and allow collecting a larger amount of information over a shorter timeframe than incidence surveillance [25–27], and simultaneous collection of data on both HAI and AMU increased the study's efficiency. Another limitation is that the hospitals sample is not statistically representative with regard to the data on hospital structure and organization. However, because of the hospitals' size, 4321 patients were included in the sample for analy-

sis, that is around 10 % of the national number of hospital beds (46,029), far larger compared to other EU countries samples (Denmark and France: 5 %, Sweden 4 %, Germany 2 %). In conclusion, a standardized methodology for HAI and AMU prevalence estimation was successfully implemented for the first time and provided an exhaustive national and European baseline. The repetition of this survey in 2015 will allow us to determine epidemiological changes, facilitating comparisons between hospitals in Austria and other EU member states. In addition, it will allow supervising the effectiveness of infection prevention and control programs. The study also increased the HAI surveillance skills and awareness of healthcare workers in the country, essential prerequisite for infection control activities to be effective.

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Compliance with ethical standards

Financial support
No financial support was provided.

Conflict of interest
L. Segagni Lusignani, A. Blacky, P. Starzengruber, M. Diab-Elschahawi, T. Wrba, and E. Presterl declare that there are no actual or potential conflicts of interest in relation to this article.

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