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Prevalence of healthcare-associated infections and antimicrobial resistance in acute care hospitals in Kyiv, Ukraine

A. Salmanov*, S. Vozianov, V. Kryzhevsky, O. Litus, A. Drozdova, I. Vlasenko

Shupyk National Medical Academy of Postgraduate Education, Kyiv, Ukraine

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SUMMARY

Background: Healthcare-associated infections (HAIs) are among the most common adverse events in patient care, and account for substantial morbidity and mortality.
Aim: To obtain the first estimates of the current prevalence of HAIs and antimicrobial resistance in acute care hospitals in Kyiv, Ukraine.
Methods: Prospective surveillance was conducted from January 2014 to December 2016 in five acute care hospitals in Kyiv. Definitions of HAIs were adapted from the Centers for Disease Control and Prevention's National Healthcare Safety Network.
Findings: Among 53,884 patients, 3753 (7%) HAIs were observed. The most frequently reported HAIs were respiratory tract infections (pneumonia 19.4%, lower respiratory tract infections 4.1%), surgical site infections (19.6%), urinary tract infections (17.5%) and bloodstream infections (10.6%). Death during hospitalization was reported in 7.2% cases of HAI. The micro-organisms most frequently isolated from HAIs were *Escherichia coli* (15.9%), *Staphylococcus aureus* (14.8%), *Enterococcus* spp. (10.2%), *Pseudomonas aeruginosa* (8.9%) and *Klebsiella* spp. (8.9%). Meticillin resistance was reported in 28.2% of *S. aureus*, and 14.2% of enterococci were resistant to vancomycin. Overall, 35.1% of all Enterobacteriaceae were resistant to third-generation cephalosporins, with the highest resistance rates seen in *K. pneumoniae* (53.8%) and *E. coli* (32.1%).
Conclusions: Infection control priorities in hospitals should include prevention of surgical site infections, pneumonia, bloodstream infections and urinary tract infections. These results may help to delineate the requirements for infection prevention and control in acute care hospitals.

Introduction

Healthcare-associated infections (HAIs) are a significant global threat to patient safety. HAIs are among the most common adverse events in patient care, and account for substantial morbidity and mortality [1–6]. Despite major advances in infection control interventions, HAIs remain a major public health problem and threat to patient safety worldwide [1]. Published national or multi-centre studies have reported prevalence rates of HAIs in mixed patient populations of 3.5–12% [1,5–9].

A proportion of HAIs are preventable [10,11], and HAI surveillance is one of the cornerstones of decreasing infection

* Corresponding author. Address: Shupyk National Medical Academy of Postgraduate Education, Aidyn Salmanov, 9 Dorohozhytska Str., Kyiv, 04112, Ukraine.
E-mail address: mozsago@gmail.com (A. Salmanov).

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rates in hospitalized patients [12]. Continuous monitoring of HAI rates can be used to assess the effectiveness of interventions and allows benchmarking [13]. Due to high morbidity and mortality caused by HAIs, early diagnosis and treatment of these infections with appropriate antibiotics is essential.

In Ukraine, there is no national network for prospective HAI surveillance. There is a need for ongoing surveillance to identify HAI prevention targets and reduce disparities between countries. However, resources are severely limited in Ukraine, creating difficulties implementing surveillance and establishing effective measures for infection control and HAI prevention. In Ukraine, efforts to improve infection control training and to begin HAI surveillance have been implemented. However, previous reports of HAIs in Ukraine have been limited to surgical site infections (SSIs) alone [14,15].

The aims of this study were to obtain the first estimates of the current prevalence and incidence burden of all HAIs in acute care hospitals in Kyiv (including the sites of infection and antimicrobial resistance patterns), and to assess the excess mortality attributable to HAIs.

Methods

Setting and patients

Over a 36-month period (January 2014—December 2016), this multi-centre prospective (surveillance for HAIs) study was performed in five acute care hospitals in Kyiv (total 1500 beds) that are similar in terms of medical equipment, personnel and laboratory facilities. All participating hospitals were required to have at least one full-time infection control professional, a clinical microbiology laboratory with the capacity to process cultures, at least one intensive care unit (ICU) and a data manager. Hospital staff participating in HAI surveillance underwent a training course that covered HAI case definitions and diagnoses, microbiology test ordering practices, microbiology laboratory procedures, and instructions for surveillance data collection and reporting.

Patients who were transferred to the ICU from another hospital were included, but patients with community-acquired infections were excluded. The follow-up of each patient was continued until discharge or death.

Definitions

Major and specific HAI site definitions were adapted from the Centers for Disease Control and Prevention's (CDC's) 2008 National Healthcare Safety Network (NHSN) case definitions [16]. Due to limitations in laboratory infrastructure, clinical sepsis (which is not currently included in NHSN) without microbiological confirmation was included as a type of HAI. However, institution of antimicrobial treatment by a physician without microbiological confirmation was not considered to be sufficient for diagnosis of an HAI in any other circumstance. Serologic and antigen test results were not included in case definitions because laboratories in participating hospitals did not have the capability to perform these tests.

An infection was deemed to be ICU-acquired where it occurred on or after the third calendar day in the ICU or within two calendar days of discharge from the ICU.

Multi-drug resistance was defined in accordance with current published interim standard definitions [17].

Ethics

According to the Health Research Act of Ukraine, quality assurance projects, surveys and evaluations that are intended to ensure that diagnosis and treatment produce the intended results do not require ethical approval or patient consent.

Data collection

Patients with signs or symptoms of HAIs were identified prospectively during clinical rounds. HAI data were collected on a specifically designed form. Data collected included demographics, intrinsic and extrinsic risk factors for infection, date of infection onset, clinical features, administered antibiotics, isolated pathogens and their antibiograms, and clinical outcomes.

HAIs were identified according to a simplified version of the definitions developed and recommended by CDC/NHSN [16]. All types of HAI were recorded, including symptomatic urinary tract infections (UTIs), pneumonia, bloodstream infections (BSIs) and SSIs.

Coagulase-negative staphylococci (CoNS) were only considered as pathogens when isolated from sterile sites. For BSIs, CoNS and other skin commensals were only considered significant when isolated from at least two blood cultures from a patient with signs or symptoms of BSI.

Microbiological methods

Microbial isolates were identified and antimicrobial susceptibilities were determined using an automated microbiology system (Vitek-2; bioMérieux, Marcy l'Etoile, France). Some further antimicrobial susceptibility testing was performed using the Kirby—Bauer method, and interpreted according to the criteria of the Clinical and Laboratory Standards Institute (CLSI). All *Klebsiella* spp. and *Escherichia coli* isolates were tested for extended-spectrum beta-lactamase production by combination disc testing according to CLSI guidelines.

Statistical analysis

HAIs were analysed as a binary exposure variable (no HAI, any HAI). HAIs were also analysed by type of infection, which were mutually exclusive. The analysis of statistical data was performed using Excel (Microsoft Corp., Redmond, WA, USA). Results are expressed as median (range), mean $\pm$ standard deviation for continuous variables, and number and corresponding percentage for qualitative variables. The primary endpoint was the epidemiology of the micro-organisms isolated in intra-abdominal samples and their resistance to antibiotics. Comparisons were undertaken using Student's *t*-test and Pearson's chi-squared test or Fisher's exact test for categorical variables as appropriate. Statistical significance was defined as $P<0.05$.

Results

Prevalence and type of infection

During the study period, 3753 of 53,884 patients were found to have HAIs. The prevalence of patients with at least one HAI in the acute care hospitals in Kyiv was 7.0% [95% confidence interval (CI) 6.8–7.2]. Ninety-seven percent of patients with an HAI were receiving at least one antimicrobial on the day of the survey.

The most frequent types of HAI were pneumonia and lower respiratory tract infections (LRTIs) (19.4% and 4.1%, respectively), SSIs (19.6%), UTIs (17.5%) and BSIs (10.6%) (Table I). Of the 232 patients with clinical sepsis, 104 were neonates.

Table I
Types of healthcare-associated infection (HAI) (*N*=3753) in acute care hospitals in Kyiv, Ukraine (2014–2016)

HAI type	*N* (%) of cases	95% CI
Pneumonia	728 (19.4)	18.2–20.6
Other lower respiratory tract infections	154 (4.1)	3.5–4.7
Surgical site infections	735 (19.6)	18.4–20.8
Urinary tract infections	660 (17.6)	16.4–18.8
Bloodstream infections	398 (10.6)	9.6–11.6
Catheter-related infections without bloodstream infection	60 (1.6)	1.2–2.0
Cardiovascular system infections	53 (1.4)	1.0–1.8
Gastrointestinal system infections	23 (0.6)	0.4–0.8
Skin and soft tissue infections	255 (6.8)	6.0–7.6
Bone and joint infections	173 (4.6)	4.0–5.2
Central nervous system infections	71 (1.9)	1.5–2.3
Eye, ear, nose or mouth infections	113 (3.0)	2.4–3.6
Reproductive tract infections	68 (1.8)	1.4–2.2
Clinical sepsis (no microbiological confirmation)	232 (6.2)	5.4–7.0
Other/unknown	30 (0.8)	0.6–1.0

CI, confidence interval.

Characteristics: origin, time to infection onset and association with device use

Eight hundred and seventy-eight (23.4%) HAIs were present on admission. Of these, 480 (54.7%) were associated with a previous stay in the same hospital, and 273 (31.1%) were associated with a previous stay in another hospital; in the remaining 125 cases, the origin was not recorded. One-third of HAIs present on admission were SSIs (Table II).

For the 2875 HAIs with onset during the current hospital stay, the median duration of hospital stay before HAI onset was 12 days (mean 21.8 days) (Table II). Most cases of pneumonia and UTI were device-associated, whereas a minority of BSIs were central-line-associated (Table III).

Patient demographics and risk factors for HAIs

Patient demographics and risk factors for HAIs are shown in Table IV.

Table II
Timing of onset of 3753 healthcare-associated infections (HAIs) in acute care hospitals in Kyiv, Ukraine (2014–2016)

	N (%) of cases	95% CI
HAIs present on admission	878 (23.4)	22.0–24.8
Originating in same hospital	480 (54.7)	53.1–56.3
Originating in another hospital	273 (31.1)	29.6–32.6
Other origin/unknown origin	125 (14.2)	13.1–15.3
HAIs with onset during current hospitalization	2875 (76.6)	75.2–78
Originating in same hospital	2789 (97.0)	96.5–97.5
Originating in another hospital	28 (1.0)	0.7–1.3
Other origin/unknown origin	58 (2.0)	1.6–2.4
Day of HAI onset[a]		
Days 1–2	103 (3.6)	3–4.2
Days 3–4	336 (11.7)	10.7–12.7
Days 5–7	495 (17.2)	16–18.4
Days 8–14	736 (25.6)	24.2–27
Days 15–21	368 (12.8)	11.7–13.9
>Day 21	802 (27.9)	26.5–29.3
No data	35 (1.2)	0.9–1.5

CI, confidence interval.
[a] HAIs with onset during current hospitalization only.

The prevalence of HAIs was highest among patients admitted to ICUs, where 19.5% of patients had at least one HAI, compared with an average of 5.2% for all other specialties combined. ICU patients accounted for 5.0% of the total hospital population, but accounted for 16.5% of all patients with an HAI. The most common HAI types in the ICU were respiratory infections and BSIs. Unsurprisingly, UTIs were the predominant HAI type in urology/other specialties, while SSIs were the most common infection type in surgery and obstetrics and gynaecology. Among paediatric patients, clinical sepsis accounted for an important segment of HAIs.

Patient risk factors included 53,884 patients, or 93% of the total number of patients in the survey. The overall prevalence of HAIs among these patients was 7.0%. All risk factors were significantly associated with the prevalence of HAIs ($P<0.001$ after adjustment for all factors in the model). Also, 72% risk factor sub-levels included in the model were significantly associated at the $P<0.001$ level, while five risk factor levels were included for consistency although they were not significantly associated at the $P<0.01$ level (cardiology, unknown surgery, unknown length of stay). The strongest independent associations were observed for length of hospital stay before HAI onset and the presence of intubation and urinary catheters (before the onset of pneumonia and UTIs, respectively).

Impact of HAIs on inpatient mortality

Of the cases of HAI identified, 237 (6.3%) died before discharge. Mortality was higher among men than women, and increased with age for both sexes. Patients with an acute admission to the hospital had a higher mortality rate than those with an elective admission. A high McCabe score was also associated with increased mortality.

Following adjustment for confounding factors, patients with HAIs were found to have a significantly higher risk of mortality compared with patients without HAIs. The highest mortality

Table III
Key characteristics associated with common types of healthcare-associated infection (HAI) in acute care hospitals in Kyiv, Ukraine (2014—2016)

Type of HAI	Characteristic	*N* (%) of cases	95% CI
Pneumonia (*N*=728)[a]	Intubation within 48 h before onset	434 (59.6)	58—61.2
	No intubation	242 (33.2)	31.7—34.7
	No data	52 (7.1)	6.3—7.9
Urinary tract infections (*N*=660)	Urinary catheter within 7 days before onset	393 (59.5)	57.9—61.1
	No urinary catheter	237 (35.9)	34.4—37.4
	No data	30 (4.5)	3.8—5.2
Bloodstream infections (*N*=400)	Catheter-related bloodstream infection	158 (39.5)	37.9—41.1
	Central venous catheter	133 (33.2)	31.7—34.7
	Peripheral venous catheter	25 (6.2)	5.4—7
	Respiratory tract infection related	17 (4.2)	3.6—4.8
	Urinary tract infection related	32 (8.0)	7.1—8.9
	Surgical site infection related	20 (5.0)	4.3—5.7
	Digestive tract infection related	19 (4.8)	4.1—5.5
	Skin/soft tissue infection related	9 (2.2)	1.7—2.7
	Other infection site	18 (4.5)	3.8—5.2
	No infection site identified	78 (19.5)	18.2—20.8
	No data	48 (12.0)	11—13

CI, confidence interval.
[a] Includes pneumonia subcategories PN1-PN5, PN-Nos and pneumonia in neonates.

risk was observed in patients with BSIs, followed by patients with pneumonia. No increased risk of death was found in patients with UTIs and SSIs.

Micro-organisms causing HAIs

In total, 4809 specimens were isolated from 3753 patients with HAIs (Table V). Overall, Gram-negative bacteria predominated, and *E. coli* was the most common species. Gram-positive bacteria were the most common causes of SSIs and BSIs, and Gram-negative bacteria were the most common causes of respiratory tract infections. Antimicrobial susceptibility testing data were available on the day of the survey for 92.0% of micro-organisms reported as causing HAIs. Meticillin resistance was found in 28.2% of *Staphylococcus aureus* isolates, and vancomycin resistance was found in 14.2% of enterococci. Non-susceptibility to third-generation cephalosporins was detected in 35.1% of all Enterobacteriaceae, and was most common among *Klebsiella pneumoniae* (53.8%) and *E. coli* (32.1%). Carbapenem resistance was found in 8.7% of Enterobacteriaceae, and in 33.1% and 63.2% of *Pseudomonas aeruginosa* and *Acinetobacter baumannii* isolates, respectively.

Discussion

This study presents the first data on HAIs in acute care hospitals in Kyiv city, Ukraine. The majority of countries in the European Union have reported the same four types of HAI as being most common: pneumonia and LRTIs, SSIs, UTIs and BSIs. The percentage of pneumonia and LRTIs varied between 12.0% in Sweden and 36.3% in Lithuania. The percentage of UTIs varied between 10.1% in Cyprus and 30.7% in France. The proportion of SSIs varied between 8.8% in Luxembourg and 29.0% in Spain. BSIs were highest in Greece (18.9%) and Cyprus (19.0%) and lowest in Iceland (2.0%), and were secondary to another infection in 28.8% of cases (ranging from 0% in Iceland, Latvia and Romania to ≥40% in Belgium, Denmark, Estonia, Germany, Luxembourg, Malta, the Netherlands, Norway, Slovenia and Sweden) [18].

Relatively few comparable studies of the overall burden of HAIs have been performed to date. These have mostly been at regional or single-centre level [1,18], with only a few studies at national level [1,4,5]. Other multi-centre studies have focused on ICUs, or on a single type of HAI and/or antibiotic resistance phenotype [19,20].

Comparison of results between different studies is difficult because of differences in patient case mix and methodology. However, the prevalence rate of 7% found in this study sits in the middle of the range of 3.5—12% for other studies [1,5—8]. Only a few studies have estimated the impact of HAIs on mortality, and, as in this study, they have reported increased mortality [2,4,21,22]. In common with other studies, this study found that patients with BSIs and patients with LRTIs were at increased risk of dying during the follow-up period [2,4,21]; likewise, the present results concur with other studies that patients with SSIs were not at increased risk of mortality [21,22]. However, in contrast to Fabbro-Peray *et al.*, the present study also found that patients with UTIs were not at increased risk of mortality [21].

In the present study, Gram-negative bacteria were the most common pathogens, in agreement with several surveillance studies in the USA [23], Europe [18], Saudi Arabia [24] and Brazil [25]. Among these Gram-negative bacteria, *E. coli, P. aeruginosa, Klebsiella* spp. and *Acinetobacter* spp. were reported most frequently. This finding is of particular concern as these organisms are often involved in outbreaks that require the activation of an organizational response until the outbreak is under control [20]. Moreover, the high rates of resistance to multiple antibiotics found in this study are of concern.

Table IV
Patient demographics and risk factors for healthcare-associated infections (HAIs) in patients with and without HAIs at acute care hospitals in Kyiv, Ukraine (2014—2016)

Characteristics	All patients		HAIs				Prevalence of HAIs (95% CI)
			No		Yes		
	N	%	*N*	%	*N*	%	
All	53,884	100.0	50,131	93.0	3753	7.0	6.8—7.2
Sex							
Male	25,284	46.9	23,542	93.1	1742	6.9	6.6—7.2
Female	28,600	53.1	26,589	93.0	2011	7.0	6.7—7.3
Age							
<1 month	1898	3.5	1710	90.1	188	9.9	8.6—11.2
1—11 months	1284	2.4	1176	91.6	108	8.4	6.9—9.9
1—44 years	11,775	21.9	11,154	94.7	621	5.3	4.9—5.7
45—74 years	22,171	41.2	20,721	93.5	1450	6.4	6.1—6.7
75—84 years	10,916	20.3	10,075	92.3	841	7.7	7.2—8.2
≥85 years	5840	10.8	5295	90.1	545	9.3	8.6—10.0
Length of stay (days)							
1—3	17,888	33.2	17,473	97.7	415	2.2	2.0—2.4
4—7	14,678	27.2	13,837	94.3	841	5.7	5.3—6.1
8—14	10,515	19.5	9683	92.1	832	7.9	7.4—8.4
≥15	10,542	19.6	8890	84.3	1652	15.7	15.0—16.4
Unknown	261	0.5	248	95.0	13	4.9	2.3—7.5
McCabe score							
Non-fatal	35,731	66.3	34,183	95.7	1548	4.3	4.1—4.5
Ultimately fatal	8695	16.2	7799	89.7	896	10.3	9.7—10.9
Rapidly fatal	2819	5.2	2439	86.5	380	13.5	12.2—14.8
Missing	6639	12.3	5710	86.0	929	14.0	13.2—14.8
Surgery since admission							
No surgery	38,933	72.3	37,093	95.3	1840	4.7	4.5—4.9
NHSN surgery	10,864	20.2	9764	89.9	1100	2.3	2.0—2.6
Minimal/non-NHSN surgery	4087	7.5	3806	93.1	281	8.1	7.3—8.9
Presence of invasive devices							
Intubation	1199	2.3	830	69.2	369	30.8	28.2—33.4
Urinary catheter	9196	17.1	7895	85.9	1301	14.2	13.5—14.9
Central vascular catheter	4022	7.5	3806	94.6	974	24.2	22.9—25.5
Peripheral vascular catheter	24,967	46.3	23,062	92.4	1905	7.6	7.3—7.9
Patient/consultant specialty							
Digestive tract surgery	1096	2.0	984	89.8	112	10.7	8.9—12.5
Cardiovascular surgery	1255	2.3	1132	90.2	123	9.8	8.2—11.4
Ear/nose/throat surgery	741	1.4	720	97.2	21	2.8	1.6—4.0
Urology	1414	2.6	1337	94.6	77	5.4	4.2—6.6
Burns care	46	0.1	35	76.1	11	22.8	14.7—32.9
Haematology	887	1.6	742	83.7	145	16.4	14.0—18.8
Pneumology	2180	4.0	2081	95.5	99	4.5	3.6—5.4
Paediatrics general	1964	3.6	1929	98.2	35	1.8	1.2—2.4
Medical ICU	627	1.2	519	82.8	108	17.2	14.2—20.2
Surgical ICU	493	0.9	371	75.3	122	24.7	20.9—28.5
Paediatric ICU	188	0.3	158	84.0	30	15.7	10.5—20.9
Neonatal ICU	535	1.0	477	89.2	58	10.9	8.3—13.5
Mixed and other ICU	784	1.5	576	73.5	208	26.5	23.4—29.6
Obstetrics/maternity	2861	5.3	2831	99.0	30	1.1	0.7—1.5
Gynaecology	1262	2.3	1228	97.3	34	2.7	1.8—3.6

NHSN, National Healthcare Safety Network; ICU, intensive care unit; CI, confidence interval.

Study strengths and limitations

The strengths of this study lie in its prospective nature, and application of NHSN methodology. It is well known that indicators of HAIs provided by surveillance activities require comparison with adequate reference data to stimulate further infection control actions and to enhance quality of care.

Table V
Types of micro-organisms (*N*=4809) isolated from 3753 healthcare-associated infections (HAIs) in acute care hospitals in Kyiv, Ukraine (2014—2016)

Micro-organisms[a]	*N* (%) of isolates				
	All HAIs	PNEU/LRTIs	SSIs	UTIs	BSIs
Gram-positive cocci	1727(35.9)	182 (19.8)	572 (46.5)	148 (16.8)	195 (47.3)
Staphylococcus aureus	712 (14.8)	116 (12.6)	221 (18.0)	16 (1.8)	66 (15.9)
CoNS	361 (7.5)	16 (1.7)	118 (9.6)	12 (1.4)	75 (18.2)
Enterococcus spp.	492 (10.2)	20 (2.2)	178 (14.5)	110 (12.5)	34 (8.2)
Streptococcus spp.	117 (2.4)	25 (2.7)	44 (3.6)	6 (0.7)	12 (2.8)
Other Gram-positive cocci	45 (0.9)	5 (0.5)	11 (0.9)	4 (0.4)	8 (1.9)
Gram-negative bacilli	2770 (57.6)	639 (69.7)	607 (49.3)	675 (76.9)	186 (45.2)
Enterobacteriaceae	2008 (41.8)	295 (32.2)	449 (36.5)	572 (65.1)	122 (29.4)
Citrobacter spp.	107 (2.2)	7 (0.8)	13 (1.1)	12 (1.4)	2 (0.4)
Enterobacter spp.	236 (4.9)	46 (5.0)	92 (7.5)	34 (3.9)	14 (3.4)
Escherichia coli	767 (15.9)	81 (8.8)	172 (14.0)	318 (36.2)	45 (10.9)
Klebsiella spp.	430 (8.9)	105 (11.4)	74 (6.0)	105 (12.0)	40 (9.8)
Proteus spp.	188 (3.9)	22 (2.4)	44 (3.6)	69 (7.9)	8 (1.9)
Serratia spp.	162 (3.4)	54 (5.9)	32 (2.6)	7 (0.6)	8 (1.9)
Other Enterobacteriaceae	118 (2.5)	10 (1.1)	22 (1.8)	27 (3.1)	5 (1.3)
Non-fermenting Gram-negative bacteria	762 (15.8)	314 (34.2)	158 (12.8)	103 (11.7)	64 (15.5)
Acinetobacter spp.	238 (4.9)	112 (12.2)	37 (3.0)	22 (2.5)	26 (6.3)
Pseudomonas aeruginosa	429 (8.9)	160 (17.4)	106 (8.6)	74 (8.4)	31 (7.5)
Stenotrophomonas maltophilia	71 (1.5)	29 (3.2)	7 (0.6)	0	4 (1.0)
Other Pseudomonadaceae	24 (0.5)	13 (1.4)	8 (0.9)	7 (0.8)	3 (0.7)
Fungi	312 (6.5)	96 (10.5)	52 (4.2)	55 (6.3)	31 (7.5)
Candida spp.	295 (6.1)	72 (7.8)	48 (3.9)	54 (6.2)	30 (7.4)
Aspergillus spp.	19 (0.4)	18 (2.0)	1 (0.1)	0	0
Total no. of isolates	4809	917	1231	878	412

PNEU/LRTIs, pneumonia/lower respiratory tract infections; SSIs, surgical site infections; UTIs, urinary tract infections; BSIs, bloodstream infections; CoNS, coagulase-negative staphylococci.
[a] Used 'The Bergey's Manual of Determinative Bacteriology', 9th edn.

However, the limitations of this study also need to be noted. Case ascertainment may have been suboptimal for several reasons. First, the case definitions were relatively complex and healthcare workers were unfamiliar with definitions prior to the start of surveillance; second, due to limitations in resources, microbiology and laboratory testing occasionally became temporarily unavailable; and third, in Ukraine, there is widespread use of empiric antimicrobial therapy and limited use of the clinical microbiology laboratory, meaning that patients may have had HAIs that were not captured by the study definitions. However, during data validation, all reported HAI cases were found to satisfy the surveillance criteria for HAIs.

In conclusion, this assessment of the burden of HAIs from the perspective of a public healthcare provider showed that the incidence of HAIs, together with their associated impact on mortality, presents a significant burden to the Ukraine hospital system. These findings, together with increasing antimicrobial resistance in hospital settings, suggest that it is time to consider systematic interventions to reduce the incidence of HAIs, including the potential development of a global national surveillance system. Routinely collected prevalence surveillance data, integrated with a patient administrative system, are of great value as a basis for studying the long-term consequences of HAIs.

Conflict of interest statement

None declared.

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None.

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