Multidrug resistance and mortality in patients with hospital-acquired urinary tract infections in Islamic Republic of Iran

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Abstract

Background: Hospital-acquired urinary tract infections are a frequent complication in intensive care units. They are increasingly being associated with multidrug-resistance, especially in low-resource settings.

Aim: To assess the uropathogenic and antimicrobial resistance patterns and identify patient-related factors associated with multidrug resistance and mortality among patients with hospital-acquired urinary tract infections in Tehran, Islamic Republic of Iran.

Methods: We analysed secondary data on all patients aged ≥ 18 years who had hospital-acquired urinary tract infections and were admitted to intensive care units of 45 public and private hospitals in Tehran, Islamic Republic of Iran, between 2022 and 2024. We examined the associations between the demographic and clinical variables using prevalence ratios and the outcomes of interest using relative risks. $P \leq 0.05$ was considered statistically significant.

Results: Of the 2467 patients, 60% were catheterised. A bacterial pathogen was isolated from 77% and *Candida* spp. from 23%. The most common pathogens were *Escherichia coli* (26%), *Klebsiella* spp. (22%) and *Candida* spp. (23%). Seventy-two percent of 1590 patients assessed exhibited multidrug resistance. Males, catheterised patients and patients with extended catheter use (> 8 days) had higher prevalence of multidrug resistance. Overall mortality rate was 42% and mortality was highest among patients with prolonged catheter use (57%), those admitted in public hospitals (51%) and those infected with *Candida spp* (60%).

Conclusion: The alarmingly high prevalence of multidrug resistance and high mortality rate among patients with hospital-acquired urinary tract infections indicate the need to enhance infection prevention and control practices in Iranian hospitals, and to significantly improve antibiotic susceptibility testing and antimicrobial resistance surveillance.

Keywords: hospital-acquired urinary tract infection, catheter-associated urinary tract infection, multidrug resistance, antimicrobial resistance, intensive care units, mortality, Islamic Republic of Iran.

Citation: Minaeian S, Kumar AMV, Farzami MR, Venugopal V, Nair D, Kamali K, et al. Multidrug resistance and mortality in patients with hospital-acquired urinary tract infections in Islamic Republic of Iran. East Mediterr Health J. 2026;32(4):197–205. https://doi.org/10.26719/2026.32.4.197.

Received: 10/12/2024; Accepted: 17/04/2025

Background

Health care-associated infections (HCAIs) are infections acquired by patients while receiving care in a health care facility, and they represent the most frequent adverse events occurring during health service delivery (1).

A 2023 systematic review estimated the global prevalence of HCAIs at 14%, with the highest burden reported in the African Region (27%) and the lowest in the Region of the Americas (9%) (2). Rates were substantially higher in low-income (32%) and middle-income countries (16%) than in high-income countries (6%), consistent with the findings of the 2022 WHO global report on infection prevention and control (3).

While HCAIs occur in all health care settings, they are more common among patients admitted to intensive care units (ICUs) due to underlying disease, immunosuppression, and the use of invasive devices (4). A 2023 review estimated that 68% of ICU patients, globally, developed HCAIs, more than double the 30% reported in the 2011 WHO report (1,25).

Data on the burden of HCAIs in Islamic Republic of Iran are limited. A 2018 national surveillance analysis reported an incidence of 4.2 per 1000 patient-days, with substantial variations among universities, hospitals and departments (6). ICU-associated infection rates were higher, at 16.8 per 1000 patient-days, with pneumonia and urinary tract infections (UTIs) identified as the most prevalent types (7). Among device-associated in-

fections, ventilator-associated pneumonia (VAP) was most common, followed by catheter-associated urinary tract infections (CAUTIs). Overall mortality attributed to HCAIs was 15.7%, although this is likely an underestimation due to reliance on passive surveillance (*7,8*).

UTIs are among the most frequently reported HCAIs, affecting between 20 and 50% of ICU patients (*9*). Horizontal transfer of resistance genes among uropathogens poses a significant challenge to treatment and infection control in these settings (*10*). The most common causes of UTI include *Escherichia coli* (*E.coli*), *Klebsiella* spp., *Citrobacter* spp, *Proteus mirabilis*, *Pseudomonas* spp., *Enterococcus* spp., *Staphylococcus saprophyticus* and *Candida* spp. (*11*).

Previous studies from Islamic Republic of Iran on hospital-acquired UTIs have typically been single-centre, with limited sample sizes, and have often focused on the specific resistance patterns of a single pathogen (*12–16*). Studies examining risk factors for multidrug resistance (MDR) – defined as resistance to 3 or more classes of antibiotics and mortality are scarce (*17*). While national reports provide a broad overview, they remain insufficient for guiding decision-making at the hospital level. Given the wide variation in the burden and resistance patterns of hospital-acquired UTIs across hospitals, up-to-date local data are essential for instituting effective hospital-level policies on treatment and antibiotic selection.

Accordingly, we undertook this operational research among patients with hospital-acquired UTIs admitted to the ICUs of hospitals within the jurisdiction of Iran University of Medical Sciences between 2022 and 2024, to determine: (i) the types of pathogens isolated and their antibiotic resistance patterns; (ii) the proportion of cases with MDR and associated mortality; and (iii) demographic and clinical factors associated with MDR and mortality.

Methods

Study setting

Islamic Republic of Iran is located in the WHO Eastern Mediterranean Region, with a population of approximately 84 million and a per capita gross domestic product (GDP) of US$ 4400, classifying it as a lower-middle-income country (*18*). The country has 1066 hospitals, 75% of which are public. Licensing and accreditation are managed by medical universities in coordination with the Ministry of Health and Medical Education (MOHME).

This study was conducted in 45 hospitals within the jurisdiction of Iran University of Medical Sciences (IUMS), one of the leading academic institutions in Tehran, the capital city. These included 7 public academic hospitals, 5 public non-academic hospitals and 33 private hospitals. Most of them were tertiary-level hospitals, with a few offering secondary care services. The facilities were geographically distributed from the northwest to the southwest of Tehran. Some hospitals operated more than one ICU, categorized as surgical ICU, medical ICU, paediatric ICU and neonatal ICU.

Upon admission to ICU, patients underwent a comprehensive physical examination and baseline laboratory tests including haematology, biochemistry, urinalysis, urine culture and antimicrobial susceptibility testing, as appropriate. Urine samples are taken only from patients with symptoms suggestive of UTI, or when clinically warranted at the discretion of the attending physician.

As per national guidelines, which are closely aligned with the criteria of the United States Centers for Disease Control and Prevention/National Healthcare Safety Network (CDC/NHSN), catheter-associated urinary tract infection (CAUTI) is defined as a UTI in a patient with an indwelling urinary catheter in place for more than 48 hours prior to the onset of symptoms. The patient must exhibit at least one of the following: fever (temperature > 38°C), urgency, frequency, dysuria, suprapubic pain or costovertebral pain/tenderness. Positive urine culture was defined as ≥ 105 colony-forming units (CFU)/mL involving no more than 2 isolated species. Hospital-acquired urinary tract infection was defined as a UTI occurring ≥ 48 hours after hospital admission, presenting with the above symptoms (*19*). Asymptomatic bacteremic UTI was defined as the absence of urinary symptoms with concurrent positive urine and blood cultures for the same uropathogen.

All participating hospitals had microbiology laboratory capabilities to perform antimicrobial susceptibility testing. Culture and testing were conducted manually using the disk diffusion method, following national protocols aligned with the Clinical and Laboratory Standards Institute (CLSI) 2024 guidelines (*20*). Antibiotics were tested against identified organisms and results were reported as susceptible, intermediate or resistant.

Candida spp. were considered clinically significant only if they met national diagnostic criteria, including both clinical symptoms and a urine culture of ≥ 105 CFU/mL. Asymptomatic bacteriuria was included only when associated with positive blood cultures suggestive of urosepsis, consistent with national surveillance definitions.

Minimum inhibitory concentration (MIC) testing was performed for resistant organisms when available, while molecular resistance testing was limited to selected hospitals for research purposes.

Study design

This was a retrospective analysis of secondary data collected as part of the national surveillance-based cohort study.

Every hospital was staffed with an infection prevention and control (IPC) nurse responsible for the documentation and reporting of HCAIs, in line with the guidelines of the Iranian nosocomial infection surveillance (INIS) system. INIS was launched in 2007 and scaled up nationally, with ≈98% of hospitals participating as of 2023. Two standardised forms were used: Form 1(individual case form) capturing demographic, clinical and laboratory data, and Form 2 collecting denominator data (e.g.

patient-days, device-days) for incidence calculation. Data were submitted monthly into the INIS database by the IPC nurse. Then, they were compiled and analysed centrally by the Iranian Centre for Disease Control at MOHME.

We included all patients with hospital-acquired UTIs admitted to ICUs of public and private hospitals operating within the jurisdiction of IUMS between 2022 and 2024.

From the INIS database, we extracted the following data on each patient: age, sex, catheterisation status and duration (interval between catheter insertion and infection), ICU type, infection duration (interval between symptom onset/sample collection and discharge or death), isolated uropathogens, antimicrobial resistance patterns, and mortality.

Data analysis

Data were exported from the INIS database into Microsoft Excel and analysed using Stata version 16.0. Categorical variables were summarised as frequencies and percentages, and continuous variables as medians and interquartile ranges (IQR). Associations between demographic and clinical variables and the outcomes of interest (MDR and mortality) were examined using prevalence ratios and relative risks, respectively, with 95% confidence intervals (CIs), calculated via modified Poisson regression.

All available variables were retained in the multivariable model, after assessing and excluding collinearity. Variables included in the MDR analysis were age, sex, hospital sector (public or private), ICU type, symptom status, comorbidities, referral status, catheterisation, catheter duration, and pathogen. Variables included in the mortality analysis were age, sex, hospital sector, ICU type, symptom status, comorbidities, referral status, catheterisation and MDR status.

$P \leq 0.05$ was considered statistically significant.

Ethics approval

Ethics approval was obtained from the Ethics Advisory Group of the International Union Against Tuberculosis and Lung Disease (11/24, dated 02-02-2024) and the Institutional Ethics Committee of Iran University of Medical Sciences (IR.IUMS.REC.1402.1046, dated 02-07-2024). Permission to access data was obtained from MOHME officials. This study complied with the Declaration of Helsinki and national data protection regulations, using secondary data from INIS, which included only medical records. The study was observational and had no impact on patient care. The dataset was fully anonymised, ensuring no personally identifiable information was included. Access was restricted to authorised researchers, to prevent unauthorized use or manipulation.

Results

Demographic and clinical characteristics

Table 1 shows the demographic and clinical characteristics of the study population. Of the 2467 patients included, 1318 (53%) were female. The median age was 71 years (IQR: 58–81). A total of 1154 patients (47%) were admitted to ICUs in private hospitals. Asymptomatic bacteriuria was identified in 322 patients (13%). Overall, nearly half of the patients had at least one comorbidity, and 277 (11%) were referred from other hospitals.

Catheter-associated urinary tract infections

A total of 1479 patients (60%) were catheterised, of whom approximately 75% were catheterised on the day of admission or earlier, in the case of referred patients. The median duration between catheterisation and infection was 8 days (IQR: 2–18). Overall, the median time from hospital admission to onset of infection was 6 days (IQR: 1–16), and from admission to outcome (death or discharge) was 18 days (IQR: 9–35).

Common uropathogens and resistance patterns

A bacterial pathogen was isolated in 1891 patients (77%), while *Candida* spp. was identified in the remaining 565 (23%). Among the bacteria, *E. coli* (26%) was the most common pathogen, followed by *Klebsiella* spp. (22%), *Pseudomonas* spp. (10%), *Enterococcus* spp. (7%) and *Acinetobacter* spp. (4%). Table 2 presents the number of bacterial isolates tested for susceptibility and resistance across different antibiotic classes. The proportion tested varied from 0% to 85%, depending on the organism and antibiotic class. Among those tested, high levels of resistance were observed across most antibiotic groups.

Multidrug resistance

Of the 1891 patients with bacterial UTI, 301 (12%) were not assessed for MDR, because they had not been tested for at least 3 classes of antibiotics. Among the remaining 1590 patients, 1148 (72%; 95% CI: 70–74%) were found to have MDR. Multivariable analysis (Table 3) showed that males had a higher prevalence of MDR than females. Patients who were catheterised – particularly those with catheterisation exceeding 8 days – had significantly higher MDR prevalence than non-catheterised patients. Among bacterial isolates, *Acinetobacter* spp. had the highest prevalence of MDR (97%), followed by *Pseudomonas aeruginosa* (90%), *Klebsiella* spp. (80%) and *Enterobacter* spp. (79%).

Mortality

Outcome data were missing for 19 patients. Among those whose outcomes were recorded, 1024 (42%, 95% CI: 40–44%) died, and the rest were discharged. Multivariable analysis (Table 4) indicated that mortality was significantly higher among patients who had been catheterised for more than 8 days prior to infection. Patients infected with *Candida* or other fungal pathogens had the highest risk of mortality compared with those infected with non-MDR bacteria. Mortality was also higher among patients admitted to public hospitals than among those in private hospitals.

Table 1 Demographic and clinical characteristics of patients with hospital-acquired urinary tract infections admitted to the intensive care units of hospitals within the jurisdiction of Iran University of Medical Sciences, 2022–2024

Characteristic	N	%
Age (years)		
< 15	77	3.1
15–59	583	23.6
≥ 60	1807	73.2
Sex		
Male	1147	46.5
Female	1318	53.4
Not recorded	2	0.1
Sector		
Private	1154	46.8
Public	1313	53.2
Type of ICU		
Medical ICU	1868	75.7
Surgical ICU	506	20.5
NICU and PICU	93	3.8
Symptom		
Asymptomatic	322	13.0
Symptomatic	2145	87.0
Comorbidities		
Present	1123	45.5
Absent	1344	54.5
Referral from external facility		
Yes	277	11.2
No	2190	88.8
Urinary catheterisation		
Yes	1479	59.9
No	988	40.1
Organism isolated		
Escherichia coli	634	25.7
Klebsiella spp.	552	22.4
Pseudomonas	258	10.5
Enterococcus spp.	177	7.2
Acinetobacter	104	4.2
Staphylococcus spp.	54	2.2
Enterobacter	34	1.4
Candida	565	22.9
Others*	89	3.6
Not Recorded	19	0.8
Total	**2467**	**100**

*Others included Citrobacter, Chlamydia sp., Burkholderia, Proteus, other viruses and fungi.
**ICU = intensive care unit; MICU = medical ICU; SICU = surgical ICU; NICU = neonatal ICU; PICU = paediatric ICU

Discussion

This study contributes to the existing evidence base in Islamic Republic of Iran regarding the predominant uropathogens responsible for hospital-acquired UTIs in ICUs, their antimicrobial resistance patterns, including MDR and associated mortality. Four key findings emerged. First, approximately 60% of patients with UTIs were catheterised. Second, the most commonly isolated uropathogens were *E. coli*, *Candida* spp., *Klebsiella* spp. and *Pseudomonas aeruginosa*. Third, around 70% of patients were infected with MDR organisms, with MDR significantly associated with sex, catheter use, duration of catheterisation and bacterial species. Fourth, mortality was 42%

Table 2 Testing and resistance levels among the common bacterial isolates of patients with hospital-acquired urinary tract infections admitted to the intensive care units of hospitals within the jurisdiction of Iran University of Medical Sciences, 2022–2024

Drug class	*E coli* (n = 634)		*Klebsiella* (n = 552)		*Pseudomonas* (n = 258)		*Enterococcus* (n = 177)		*Acinetobacter* (n = 104)	
	Number tested	Resistance %	Number tested	Resistance %	Number tested	Resistance %	Number tested	Resistance %	Number tested	Resistance %
Macrolides	13	92	11	91	0	–	23	96	0	–
Cephalosporins	538	77	451	85	215	90	22	86	74	95
Penicillin	75	81	61	97	35	94	118	79	15	93
Tetracycline	89	55	98	65	65	94	47	83	43	72
Glycopeptides	N/A	N/A	N/A	N/A	N/A	N/A	136	67	N/A	N/A
Fluoroquinolones	487	69	429	82	199	85	114	82	71	93
Carbapenem	446	22	390	67	212	84	27	59	69	94
Betalactams	265	57	224	83	154	89	10	40	53	85
Aminoglycosides	525	32	449	64	209	78	56	64	72	85
Oxazolidines	N/A	N/A	N/A	N/A	N/A	N/A	111	6	N/A	N/A
Chloramphenicol	52	12	64	64	46	93	7	29	14	100
Sulfonamide	303	71	256	79	93	0	24	75	40	75
Nitrofurantoin	456	14	378	68	94	98	111	10	38	97
Rifamycin	0	–	0	–	0	–	11	82	0	–

*N/A = not applicable

(more than 4 out of every 10 patients), highlighting the severity of these infections.

Catheter use and the duration of catheterisation remain the most important factors in the development of bacteriuria (*21*). In a study by Tasseau et al, each day of catheterisation increased the risk of developing UTI by 5%, depending on the most common species and its antibiogram, with almost all patients being colonised by day 30 (*22*). A previous study from Islamic Republic of Iran reported an MDR prevalence of 85.9% in catheter-associated UTIs in ICUs, consistent with our findings (*23*).

MDR prevalence was higher among males than females. This may be associated with structural abnormalities such as urolithiasis and comorbidities like benign prostatic hypertrophy, common in elderly males associated with poor drainage of urine, as well as the use of long-term indwelling catheters, which complicate infection eradication and prolonged antibiotic use, potentially leading to the development of resistance (*24*). MDR levels were higher in public hospitals than private hospitals. This pattern may reflect overcrowding in relatively under-resourced public hospitals with possibly suboptimal IPC practices. This requires further research. The common uropathogens identified in our study are consistent with other studies from Islamic Republic of Iran and elsewhere, with minor variations in the relative proportions (*22,24–27*).

Mortality in our study was 42% – substantially higher than reported in a previous study from Islamic Republic of Iran (*28*). Previous studies from different countries have reported various mortality rates: USA (2.3%), Peru (19%), Germany (27%), India (28%), Tunisia (33%), and Sweden (42%) (*29*). *Candida* was isolated in about 25% of patients in our study and these patients had a higher risk of mortality (60%) than those with UTIs caused by bacteria (32%). This may reflect the underlying immunocompromised state of the patients and the presence of comorbidities. We did not have information about the species of *Candida* or their resistance patterns to different classes of antifungals. With the emergence of resistant 'superbugs' such as *Candida auris*, information about species and resistance patterns is crucial to inform effective treatment options.

In our study, longer catheterisation duration was associated with higher mortality. Previous studies have reported conflicting findings on catheter-associated UTI and mortality, with one study reporting no association (*30*) and another reporting an independent association with mortality (*31*). This warrants further research.

Other reported risk factors for mortality include: age, length of stay in the ICU, central line days, mechanical ventilator use ratio, central line-associated bloodstream infection acquisition, ventilator-associated pneumonia acquisition, female sex, and hospitalisation in a public hospital (*30*). We found higher mortality in public hospitals than in private hospitals; the reasons for this difference are unclear and require further investigation.

Our study had several strengths. We included all hospitals, including those in the private sector, within the jurisdiction of the Iran University of Medical Sciences, making the findings representative of the area covered. The large sample size enabled robust analysis of factors associated with MDR. Use of routine surveillance data for this operational research means the findings reflect the realities in Islamic Republic of Iran. We reported the study in accordance with the STROBE guidelines (*32*).

Table 3 Factors associated with multidrug resistance among patients with hospital-acquired urinary tract infections admitted to the intensive care units of hospitals within the jurisdiction of Iran University of Medical Sciences, 2022–2024 (n = 1590)*

Characteristic	Total	MDR		Adjusted		*P*
		N	%	PR	(95% CI)	
Age (years)						
< 15	52	38	73	1.10	(0.88–1.38)	0.384
15–59	386	273	71	Ref		
≥ 60	1152	837	73	1.06	(0.99–1.14)	0.090
Sex						
Male	731	568	78	1.09	(1.03–1.16)	0.003
Female	857	579	67	Ref		
Not recorded[$]	2	1	50	–	–	
Sector						
Private	723	507	70	Ref		
Public	867	641	74	1.10	(1.02–1.18)	0.005
Type of ICU						
Medical ICU	1221	867	71	1.01	(0.83–1.24)	0.888
Surgical ICU	296	230	78	1.05	(0.86–1.30)	0.621
NICU and PICU	73	51	70	Ref		
Symptom						
Asymptomatic	195	144	74	1.08	(0.98–1.19)	0.106
Symptomatic	1395	1004	72	Ref		
Comorbidities						
Present	717	524	73	1.03	(0.97–1.09)	0.355
None	873	624	71	Ref		
Referral from external facility						
Yes	236	173	73	1.09	(0.99–1.20)	0.056
No	1354	975	72	Ref		
Urinary catheterisation						
Yes (≤ 8 days)	530	375	71	1.12	(1.04–1.22)	0.002
Yes (> 8 days)	342	298	87	1.28	(1.20–1.37)	< 0.001
No	718	475	66	Ref		
Organism isolated						
Acinetobacter	76	74	97	1.76	(1.32-2.33)	< 0.001
E. coli	554	317	57	1.08	(0.81-1.44)	0.595
Enterobacter	24	19	79	1.42	(1.02-1.99)	0.039
Enterococcus spp.	142	97	68	1.23	(0.91–1.66)	0.187
Klebsiella spp.	446	374	80	1.49	(1.12–1.99)	0.006
Others	65	47	72	1.32	(0.96–1.82)	0.085
Pseudomonas	218	196	90	1.63	(0.96–1.82)	0.001
Staphylococcus spp.	45	24	53	Ref		
Total	**1590**	**1148**	**72**			

**N = number of bacterial isolates for which sensitivity results for at least 3 antibiotic classes were available to make an inference on MDR status; #Row percentage; [$]Excluded from regression analysis; MDR = multidrug resistant hospital acquired urinary tract infection (any bacteria that shows resistance to ≥ 3 antibiotic groups); ICU = intensive care unit; PICU = paediatric intensive care unit; NICU = neonatal intensive care unit; CI = confidence interval; Ref = reference category*

The study had some limitations, including missing data on the results of antibiotic resistance, either due to no testing or no documentation. As a result, in about one-third of patients, we could not assess MDR status. Data on comorbidities and other clinical variables were not recorded because the national guidelines, limit detailed analysis of mortality. Given the retrospective nature of this study, there was no access to other potential variables, such as the presence of central line-associated bloodstream infections, ventilator-associated pneumonia, or history of immunosuppressive drug use, which may have been important in analysing factors associated with mortality.

Table 4 Factors associated with mortality among patients with hospital-acquired urinary tract infections admitted to intensive care units of hospitals within the jurisdiction of Iran University of Medical Sciences, 2022–2024 (n = 2448)

Characteristic	Total	Mortality		Adjusted		P
		N	%	PR	(95% CI)	
Age (years)						
< 15	77	12	16	Ref		
15–59	581	233	40	1.43	(0.67–3.08)	0.356
≥ 60	1790	779	43	1.71	(0.80–3.65)	0.164
Sex						
Male	1137	488	43	1.01	(0.93–1.11)	0.799
Female	1309	536	41	Ref		
Not recorded[§]	2	0	0			
Sector						
Private	1140	358	31	Ref		
Public	1308	666	51	1.55	(1.37–1.76)	< 0.001
Type of ICU						
Medical ICU	1852	780	42	1.98	(0.95–1.14)	0.067
Surgical ICU	503	231	46	1.79	(0.86–3.75)	0.120
NICU and PICU	93	13	14	Ref		
Symptom						
Asymptomatic	321	118	37	Ref		
Symptomatic	2127	906	43	0.79	(0.66–0.94)	0.007
Comorbidities						
Present	1113	479	43	1.08	(0.98–1.18)	0.115
None	1335	545	41	Ref		
Referral from external facility						
Yes	275	71	26	Ref		
No	2173	953	44	1.60	(1.28–1.99)	
Urinary catheterisation						
Yes (≤ 8 days)	786	294	37	1.00	(0.88–1.14)	0.945
Yes (> 8 days)	687	395	57	1.36	(1.20–1.54)	< 0.001
No	975	335	34	Ref		
MDR						
Bacteria (MDR)	1141	452	40	1.15	(0.99–1.35)	0.069
Bacteria (Non-MDR)	440	139	32	Ref		
Bacteria (MDR not assessed)	293	88	30	1.04	(0.83–1.30)	0.745
Candida and other non-bacteria	574	345	60	1.44	(1.22–1.69)	< 0.001
Total	**2448**	**1024**	**42**			

[§]*Excluded from regression analysis given low number of patients; ICU = intensive care unit; NICU = neonatal intensive care unit; PICU = paediatric intensive care unit; CI = confidence interval; N/A = not applicable; Ref = reference category*

Although these limitations should be considered, the findings have important implications. First, we recommend strengthening data recording. This may require sensitisation and training of IPC nurses, who are responsible for recording and reporting surveillance data at the hospital level. Second, high levels of MDR in hospital-acquired UTIs indicate continuous nosocomial transmission and the need to strengthen IPC practices in ICUs. Third, data on antibiotic resistance patterns reported in this study can be used to inform the choice of antibiotics in empirical therapy of UTIs, while awaiting drug susceptibility results. The national clinical guidelines should be tailored at the hospital level based on periodic analysis of local surveillance data. Antibiotic stewardship committees in the respective hospitals should take the lead in this direction. Fourth, every bacterial isolate should be tested against a panel of antibiotics as recommended national and international standards. This was not always the case. The proportion tested for susceptibility varied across drug classes, being suboptimal in some instances and inappropriate in others, for example, by using incorrect antibiotics to test the bacteria. This reflects challenges in access to quality-assured supplies, issues in procurement and supply chain management of laborato-

ry consumables, and non-adherence to laboratory protocols. These issues need to be addressed. We recommend instituting testing for *Candida* speciation and antifungal susceptibility.

Conclusion

In this study covering both public and private hospitals within the jurisdiction of Iran University of Medical Sciences, we found alarming levels of MDR and mortality among patients with hospital-acquired UTIs. MDR was significantly higher among males, catheterised patients, and those infected with bacteria such as *Acinetobacter, Klebsiella* and *Pseudomonas*. Mortality was associated with extended catheterisation, public hospitals, and infection with fungal pathogens. Several operational issues related to suboptimal levels of antibiotic susceptibility testing and data recording were identified. These need to be addressed urgently to enable the generation of high-quality surveillance data and periodic analysis, thereby informing tailored treatment for patients in the university hospitals.

Acknowledgements

This study was conducted through the Structured Operational Research and Training Initiative (SORT IT), a global partnership led by TDR, the Special Programme for Research and Training in Tropical Diseases hosted by WHO. The specific SORT IT programme that led to this publication included a SORT IT partnership with the Abu Dhabi Public Health Center (ADPHC), United Arab Emirates; the United Arab Emirates University (UAEU), Al Ain, United Arab Emirates; the International Union Against Tuberculosis and Lung Disease, Paris and India offices; the Damien Foundation, Brussels, Belgium; the All India Institute of Medical Sciences, Nagpur, India; the All India Institute of Medical Sciences, Deoghar, India; the Tuberculosis Research and Prevention Center Non-Governmental Organization, Armenia; the Narotam Sekhsaria Foundation, Mumbai, India; the Ministry of Health of Islamic Republic of Iran; and the WHO Regional Office for the Eastern Mediterranean and the WHO country office in Egypt. We thank the authorities of Iran University of Medical Sciences in Tehran for providing access to the study data.

Funding: This SORT IT programme was funded by TDR, ADPHC and UAEU. TDR is able to conduct its work thanks to the commitment and support of a variety of funders. A full list of TDR donors is available at: https://tdr.who.int/about-us/our-donors.

Conflict of interest: None declared.

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