

Table 2 Summary of the main clinical features of the UTI cases and antimicrobial sensitivity/resistance profiles

Age nt and occ urr enc e pla ce	Related intrinsic/ extrinsic factors	Virulence factors	Demonstrated profiles /Resistance genes to antibiotics		Species identification methods	R e f .
			Susceptibility	Resistance / antibiotics resistance genes		
<i>Ach rom oba cter xylo soxi dan s</i> (no soc omi al)	Intrinsic: preoperative pyuria, pyelonephritis and bacteriuria.	-	-	-	Uroculture or blood culture.	9
<i>Bre vun dim ona s vesi cul aris</i> (co mm unit y and nos oco mia l)	Intrinsic: end stage renal disease; systemic lupus erythematosus; sickle cell anemia; hematological malignancy; neutropenia.	-	Piperacillin- tazobactam; minocycline; co- trimoxazole.	Amikacin; gentamicin; tobramycin; netilmicin; amoxicillin; amoxicillin- clavulanic acid; cefoxitin; cefotaxime; cefoperazone; ceftazidime; cefoperazone- sulbactam; imipenem; meropenem; ertapenem; aztreonam; norfloxacin; levofloxacin; colistin.*	Uroculture.	1 0
	Extrinsic: urethral catheter; prolonged steroid therapy.					

Burkholderia pseudomallei (community)

Intrinsic: diabetes mellitus; immunosuppressive conditions; males with prostate problems, renal abscess, epididymo-orchitis, septicemia; renal transplantation; IgA nephropathy.

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Amoxicillin-clavulanic acid; cefixime; ceftazidime; ceftriaxone; ciprofloxacin; cotrimoxazole; imipenem; mecillinam; piperacillin-tazobactam.

Amikacin; colistin; gentamicin; netilmicin; nitrofurantoin.

Uroculture.

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Extrinsic: alcoholism; use of steroid; recreational or occupational exposure (farmer); penetrating injury; coitus.

Chryseobacterium gleum (social)

Intrinsic: extremes of age; chronic disease; immunosuppression.

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Imipenem; minocycline; levofloxacin; ciprofloxacin; cotrimoxazole; intermediately sensitive to cefoperazone-sulbactam.

Gentamicin; amikacin; meropenem; doripenem; aztreonam; colistin. Expresses β -lactamase.

MALDI-TOF MS c; VITEK-2 system.

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Extrinsic: foley catheter; intravascular devices; prolonged antibiotic therapy.

Chryseobacterium indologenes (social)

Intrinsic: immunosuppression; cancer.

Biofilm; proteases; resistant to chlorination.

Piperacillin-tazobactam; vancomycin; TMP-SMX a; cefepime; rifampicin; piperacillin; ceftazidime; nalidixic acid; other quinolones; ciprofloxacin.

Cefotaxime; imipenem; aztreonam; gentamicin; amikacin; tobramycin; colistin; polymyxin; aminoglycosides; other β -lactams (including carbapenems); chloramphenicol; linezolid; glycopeptides; ampicillin; ticarcillin; temocillin; cephalothin; cefuroxime; ceftriaxone; cefotetan; meropenem; ertapenem; aztreonam. Expresses β -lactamase.

Suspected by microscopy examination; conventional biochemical reactions and API identification system (bioMérieux).

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Extrinsic: hospitalization (especially in the elderly, and underlying diseases); internal devices; prolonged antibiotic therapy (> 14 days).

<i>Edwar dsie lla tard a</i> (co mm unit y and nos oco mia l)	Intrinsic: colon colonization; cancer; immunosuppression.	-	Ampicillin; piperacillin; cefazolin; cefotaxime; cefepime; cefazopran; meropenem; gentamicin; ciprofloxacin; TMP- SMX.	-	Enterotube II Becton (Dickinson); VITEK 2 Card for Gram- Negative Bacteria (BioMerieux).	1 5
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Extrinsic: urinary stent.

<i>Eliz abe thki ngi a men ing ose ptic a</i> (no soc omi al)	Intrinsic: immunosuppression.	Biofilm; hydrophilic cell surface; adhesins; capacity to survive intracellularly.	Minocycline; characteristic sensitivity to drugs such as vancomycin and rifampin.	Amikacin; amoxicillin- clavulanic acid; ampicillin/amoxicilli n; cefotaxime/ceftriaxo ne; cefuroxime; TMP-SMX; gentamicina; norfloxacin; cefoperazone- sulbactam; cefepirome/cefepime ; imipenem; piperacillin- tazobactam; vancomycin; characteristic resistance to drugs such as colistin, third and fourth- generation cephalosporins, carbapenems, extended spectrum penicillins and aminoglycosides. Resistance genes to antibiotics.	Uroculture; MALDI-TOF MS; confirmation with 16S rRNA gene sequence analysis.	1 6
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Extrinsic: foley catheter.

<i>Enterobacter sakazakii</i> (Community and nosocomial)	Intrinsic: prematurity.	-		Amikacin; cefotaxime; cotrimoxazole; gentamicin; netilmicin; nitrofurantoin; norfloxacin.	-	Uroculture.	(1 7 , 6 5)	
	Extrinsic: contaminated powdered infant formula.							
<i>Haemophilus influenzae</i> (community)	Extrinsic: sexual intercourse with a carrier.	-	-		-	Uroculture confirmed by 16S rRNA gene sequence analysis.	1 8	
<i>Klebsiella variicola</i> (nosocomial)	-	Siderophores, allantoin utilization and glycerate pathway genes; pili expression.	Ceftazidime; meropenem; ciprofloxacin; TMP-SMX.	Ampicillin.		MALDI-TOF MS; PCR-RFLP d.	1 9	

<i>Klu</i> <i>yve</i> <i>ra</i> <i>asc</i> <i>orb</i> <i>ata</i> (co mm unit y and nos oco mia l)	Intrinsic: immunosuppression; vesicoureteral reflux; pregnancy; chronic proteinúria; underlying diseases; anatomical and functional problems.	-	Piperacillin; piperacillin- tazobactam; meropenem; cefotaxim; cefotiam; ceftazidime; ceftiprome; ceftitren pivoxil; ceftazopran; cefepime; cefcapene povixil; flomoxef; cefoperazon/clavula nic acid; imipenem/cilastatin; amikacin; gentamicin; azithromycin; tobramycin; minocycline; fosfomicin; TMP- SMX; ciprofloxacin; levofloxacin; cefdinir (intermediary); First-, second-, third generation cephalosporins; aminoglycosides; aztreonam; ticarcilin; imipenem; quinolones; nitrofurantoin; ceftriaxone; ertapenem; meropenem; ofloxacin; ampicillin- sulbactam; aztreonam; ceftazidime; tigecycline.	Cefazolin; cefmetazole; cefaclor. Expresses β -lactamase.	MicroScan (WalkAway 96 2 SI; uroculture; 0 VITEK® 2 - (bioMérieux) 2 confirmed by 3 MALDI-TOF) MS (bioMérieux) and 16S rRNA sequencing.
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<i>Myroides odorati mimus</i> (community)	Intrinsic: immunosuppression.	Biofilm (co- and self-aggregation) facilitated with higher glucose concentration; polysaccharide capsule (hydrophobic surface); <i>bauE</i> gene (competing with the hosts to acquire iron); adherence; capacity to survive intracellularly and in human stomach; easy dissemination; capacity to destroy human tissues.	TMP-SMX.	Piperacillin/tazobactam; ticarcillin/clavulanate; ceftazidime/avibactam; imipenem; meropenem; fluoroquinolones; aminoglycosides; fosfomycin; nitrofurantoin; polymyxin. Expresses β -lactamase.	MALDI-TOF MS confirmed by 16S rRNA gene sequence analysis.	2 3
	Extrinsic: use prolonged of urinary catheter and poor care; multiple hospital admissions.					
<i>Ochrobactrum anthropi</i> (frequently nosocomial)	Intrinsic: immunocompromised; posterior urethral valve.	Adherence properties.	Fully: amikacin; levofloxacin; meropenem; TMP-SMX. Intermediate: gentamicina.	Beta-lactams; aztreonam; chloramphenicol.	DNA sequencing.	2 4
	Extrinsic: indwelling catheters or other medical devices; chest tube placement; long-term indwelling foley catheterization; in neonate, history of placement of bladder shunts in utero, umbilical venous catheterization.					
<i>Raoultella planticola</i> (nosocomial)	Intrinsic: immunosuppressed status; comorbidities (diabetes, chronic renal failure).	Rapid multiplication in isotonic solutions.	Amoxicillin/clavulanic acid; ceftriaxone; ceftazidime; cefuroxime; ciprofloxacin; gentamicin; TMP-SMX; nitrofurantoin.	Ampicillin; fosfomycin.	MALDI-TOF MS (bioMérieux); VITEK-2 Compact system (bioMérieux).	2 5
	Extrinsic: post-invasive procedures; use of a contaminated isotonic solution.					

<i>Raoultella ornitholytica</i> (community and nosocomial)	Intrinsic: solid cancer; post-urethra trauma; diabetes mellitus; immunodeficiency.	Ability to adhere to human tissues and to form biofilms in urinary catheters.	Ampicillin-sulbactam; piperacillin-tazobactam; ceftriaxone; cefepime; ertapenem; ciprofloxacin; nitrofurantoin; amikacin; gentamicina; tobramycin; TMP-SMX.	Ampicillin and other aminopenicillins; amoxicillin; amoxicillin-clavulanic acid; ticarcillin-clavulanic acid; piperacillin-tazobactam; ceftriaxone; third-generation cephalosporins; carbapenems; quinolones; aminoglycoside; cotrimoxazole; ciprofloxacin. Expresses β -lactamase.	Uroculture; Vitek 2 GN ID card (BioMérieux) confirmed by 16S rRNA molecular methods; API 20E test kit (BioMérieux) or MicroScan Neg Combo 32 panel (Dade Behring) completed by an ornithine decarboxylase (ODC) test; MALDI-TOF MS.	(5, 2, 6,)
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Extrinsic: post-invasive procedures (urinary catheters).

<i>Salmonella</i> spp. (community)	Intrinsic: sickle cell anemia; systemic lupus erythematosus; diabetes mellitus; chronic diseases; genitourinary structural abnormalities (lithiasis, chronic pyelonephritis, urethrorectal and retrovesicular fistula); immunosuppression; gastroenteritis; benign prostatic hyperplasia; recent episode of typhoid fever (chronic carrier); extremes of age; middle aged women; schistosomiasis; strongyloidosis; bad T-cell function.	Biofilm.	Cefotaxim; nalidixic acid; ceftriaxone; cefixim; ciprofloxacin; gentamicin; preference for third generation cephalosporins and fluoroquinolones.	Chloramphenicol; TMP-SMX.	Blood culture; Uroculture (CLED agar; UriSelect 4 chromogenic agar); genus identification with 20E analytical profile and mass spectrometry; serotype identification with agglutination method; serotyping with agglutination with O9 and Hd antisera (Denka, Seiken Co. Ltd).	(2, 7, 2, 8, 3, 0, 3, 2, 4, 5,)
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Extrinsic: food or water contaminated; animals contaminated (commonly chickens and others birds); anal-penetrating intercourse.

<i>Aerococcus</i> sp. (community and nosocomial)	Intrinsic: elderly patients with genitourinary tract abnormality; immunocompromised patients; urogenital or neurological abnormalities.	Antiphagocytosis; adherence; endotoxin; intracellular growth/survival; stress proteins; biofilm formation (only <i>A. sanguicola</i>); beta-hemolysin/cytolysin.	Penicillin; ampicillin; cefuroxime; vancomycin; erythromycin; rifampicin.	Co-trimoxazole; ciprofloxacin.	DNA sequencing; Mass spectrometry technology; 16S rRNA gene sequencing; blood culture (incubated in a CO ₂ -enriched atmosphere).	(3 3 - 3 5)
Extrinsic: alcohol abuse.						
Group B <i>Streptococcus</i> (community and nosocomial)	Intrinsic: vesicoureteric reflux.	-	Penicillin; erythromycin; clindamycin.	-	-	3 6
Extrinsic: maternal colonization; ascending flow of organisms into the amniotic fluid or acquisition over the passage through the birth canal.						
<i>Streptococcus pneumoniae</i> (community)	Intrinsic: urinary tract abnormalities (hydronephrosis and renal stones, renal cyst, diabetic cystopathy, benign prostatic hypertrophy).	-	Amoxicillin-clavulanic acid; cefuroxime; ceftriaxone; ciprofloxacin; nitrofurantoin; co-trimoxazole.	-	Sheep blood agar with CO ₂ supplementation.	3 7
Extrinsic: perineal contamination has been reported as a result of autoinoculation with nasal secretions by transmission through unhygienic hands.						

<i>Viridans streptococcus</i> (community and nosocomial)	-	-	Methicillin; ceftriaxone.	-	Blood culture.	3 8
<i>Corynebacterium jeikeium</i> (community)	Intrinsic: age; dementia.	-	Penicillin G; ampicillin; cefazolin; cefotiam; ceftriaxone; meropenem; amikacin; minocycline; vancomycin; teicoplanin; linezolid.	Erythromycin; clarithromycin; levofloxacin; clindamycin.	16S rRNA gene sequencing.	3 9
<i>Globella sanguinis</i> (community)	Intrinsic: age; dementia.	-	Penicillin G; ampicillin; ceftriaxone; meropenem; erythromycin; clarithromycin; amikacin; minocycline; vancomycin; clindamycin; teicoplanin; linezolid.	Cefazolin; cefotiam; levofloxacin.	16S rRNA gene sequencing.	3 9

<i>Actinobaculum schaalii</i> and other actinomycetes (community)	Intrinsic: immunosuppression; kidney stones; age; enuresis; anatomical disorders; urological disease; prostatic; hyperplasia; genitourinary tract cancer.	-	B-lactams; amoxicillin; cephalosporins; gentamicin; vancomycin; linezolid; nitrofurantoin; mecillinam; rifampicin; levofloxacin; fosfomycin; TMP-SMX.	Macrolide; ciprofloxacin; metronidazole; cotrimoxazole; lincosamide; streptogramin B.	Blood-enriched media incubated 48h-72h in anaerobic or CO ₂ enriched atmosphere (samples of blood and urine); real-time quantitative PCR method using urine samples; 16S rRNA and 16S rDNA gene sequence; MALDI-TOF MS.	(4 0 - 4 4)	
<i>Corynebacterium aurimucosum</i> (community)	Intrinsic: urethral cutaneous fistula.	-	Erythromycin; pristinamycin; lincomycin; vancomycin; cephalothin; chloramphenicol; imipenem; tetracycline; ciprofloxacin.	Penicillin; cotrimoxazole.	MALDI-TOF MS.	3	
	Extrinsic: post-operative of urethroplasty because of urethral cutaneous fistula.						

<i>Corynebacterium pseudodiphtheriticum</i> (community and nosocomial)	Intrinsic: end-stage renal disease; AIDS and Mycobacterium tuberculosis infection; cancer; hepatic cirrhosis.	-	Beta-lactam agents; aminoglycosides; rifampin and vancomycin.	Oxacillin; erythromycin; clindamycin.	Columbia agar base added of 5% sheep blood and incubated at 37°C.	4 5
	Extrinsic: renal transplant; haemodialysis and catheter use.					
<i>Corynebacterium urealyticum</i> (community)	Intrinsic: local urogenital alkaline pH; Immunosuppression	Formation of struvite, ammonium magnesium phosphate concretion, and/or carbonate apatite stones.	Glycopeptides (teicoplanin or vancomycin), linezolid and quinupristin-dalfopristin (only in vitro).	-	Selective media, namely blood-agar plates. Cultures should be incubated 48 hours when this infection is suspected. Molecular detection techniques, like polymerase chain reaction, can be used.	4 6
	Extrinsic: previous broad-spectrum antibiotic cycles; past bladder trauma, prolonged bladder catheterization, and urological manipulations; renal graft recipients.					
<i>Mycoblastasma</i> sp. and <i>Ureaplasma</i> sp. (community)	Intrinsic: immunosuppression; obstruction.	-	-	Combined MH-UUb infections have a higher prevalence of antibiotic resistance especially to azithromycin and ofloxacin.	Uroculture; rtMPCR e.	(1 , 6 4)

Extrinsic: instrumentation of the urinary tract; kidney transplantation associated with immunosuppressive therapy.

<i>Gar dne rell a vag inal is (co mm unit y)</i>	Intrinsic: immunosuppression; anatomic genitourinary abnormalities.	Hemolysin and sialidase (evasion of tissue mucosal immunity); teichoic acid (systemic inflammatory response).	Penicillin; ampicillin; ceftriaxone; frythromycin; quinupristin- dalfopristin; vancomycin; rifampin; clindamycin; daptomycin; tetracycline; levofloxacin; linezolid; gentamicin; ciprofloxacin; gatifloxacin; TMP- SMX; it has also been documented successful therapy with beta-lactams, tetracyclines, cephalosporins, clindamycin, chloramphenicol, and metronidazole alone or in combination.	-	API Strep strip (bioMérieux); 16S rRNA genes sequence analysis; rtMPCR.	(1 , 6 4)
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Extrinsic: alcoholism; colonization; kidney transplantation associated with immunosuppressive therapy.

<i>Alte rna ria alte rnat a (co mm unit y)</i>	Intrinsic: immunocompromise d patients.	-	Amphotericin B; triazoles; echinocandins.	-	Sabouraud agar uroculture.	4 8
<i>Asp ergi llus sp. (co mm unit y)</i>	Intrinsic: immunocompromise d patients, urinary tract anomaly, malignancy, neonates, diabetes mellitus, neutropenia.	Stimulates severe necrotizing granulomatous inflammation.	Amphotericin B; itraconazole; voriconazole, posaconazole.	-	Histopatholog y of the transplanted kidney associated with fungal culture.	(4 9 - 5 1)

Extrinsic: post-kidney transplant, prolonged antibiotic use, indwelling urinary catheter, use of steroids, malnutrition.

<i>Candida kefyr</i> (community and nosocomial)	Intrinsic: neonates; gastrointestinal or urinary tract abnormalities; neutropenia.	Up to now <i>Candida kefyr</i> is considered as not pathogenic to healthy individuals.	Fluconazole; amphotericin B; caspofungin.	-	Biochemical identification using the API 20 C AUX (BioMerieux) biochemical identification panel. Sequencing of the internal transcribed spacer regions using primer pairs ITS 1 and ITS-4.	5 2
Extrinsic: use of broad spectrum antibiotics; central venous catheters; parenteral nutrition; bone marrow transplantation.						
<i>Cryptococcus</i> spp. (community)	Intrinsic: immunocompromised patients	-	Fluconazole.	-	Routine histological sections were stained with haematoxylin and eosin.	5 3
Extrinsic: kidney transplant.						
<i>Enterozytobacteriaceae</i> (community)	Intrinsic: immunocompromised patients.	Infect epithelial and endothelial cells, fibroblasts or macrophages.	-	-	Light microscopy and phylogeny analyses of internal transcribed spacer sequences acquired from urine specimens.	5 4
Extrinsic: HIV/AIDS, organ transplantation, chemotherapy recipients, close contact with animals.						

<i>Geotrichum</i> (community)	Intrinsic: immunocompromised patients; hematological malignancies and severe neutropenia.	-	Amphotericin B.	Flucytosine; fluconazole; itraconazole.	Sabouraud dextrose agar and ID 32C (bioMérieux); ITS rDNA sequences and nDNA/DNA reassociation.	5 5
	Extrinsic: use of corticosteroids; broad-spectrum antibiotics; cytotoxic chemotherapy; central catheter and the alteration of local defenses by obstruction of breakdown of the skin and mucosa.					
<i>Saccharomyces cerevisiae</i> (community)	Intrinsic: malignancy; HIV/AIDS; chronic kidney disease (CKD); diabetes; newborns; obstructive uropathy.	Common colonizer of the human respiratory, gastrointestinal and urinary tracts and is generally considered as a benign organism.	Amphotericin B; 5-flucytosine; fluconazole; itraconazole; voriconazole; posaconazole; isavuconazole; micafungin.	-	Pathogenic strains of <i>S. cerevisiae</i> exhibit the ability to grow at 42°C, produce proteinase and are capable of pseudohyphal growth.	5 6
	Extrinsic: bone marrow transplantation; indwelling catheter.					
<i>Trichosporon</i> (community and nosocomial)	Intrinsic: urinary obstruction; age; immunocompromised patients; patients with haematologic malignancies profoundly neutropenic; hypertension; heart failure; chronic obstructive pulmonary disease; diabetes.	Biofilms, enzymes, and cell wall components.	Triazoles (voriconazole).	Echinocandins; 5-fluorocytosine.	Mycological study based on direct examination; Vitek 2 system; PCR and DNA sequencing of the internal transcribed spacer (ITS) and IGS regions of the rRNA genes; uroculture in Cornmeal Tween 80 agar.	(5 7 - 6 0)
	Extrinsic: prolonged intravenous and bladder catheterization; cardiac prosthetic valves; hemodialysis; peritoneal dialysis; broad-spectrum antibiotics; corticosteroids therapy; organ transplantation; extensive burns.					
<i>Zygomycetes</i> (community)	Intrinsic: is related to occur in patients previously healthy, developing kidney failure and signs of sepsis.	Angiotropic (vascular invasion and infarction of the tissues).	Amphotericin B.	-	Kidney biopsy. Grow in standard laboratory media within 12–18 h after sample inoculation.	6 1

Cytomegalovirus (CMV)	Intrinsic: immunosuppression.	-	-	-	RtMPCR; pp65 or DNA detection by PCR in blood; urine isolation.	6 4
	Extrinsic: renal transplantation.					
Herpes simplex virus-2 (HSV-2)	Intrinsic: immunosuppression.	-	-	-	RtMPCR.	6 4
<i>Human papillomavirus</i> (HPV)	Intrinsic: immunosuppression;	-	-	-	Urethral mucosa smear sample analyzed with Invader® (BML Inc.).	6 2
	Extrinsic: sexual contact; transplantation.					
<i>BK polyomavirus</i> (BKV)	Intrinsic: immunocompromised patients.	Polyomavirus infection induces marked cellular degeneration and is typically associated with degenerated urothelial cells that have atypical hyperchromatic nuclei.	-	-	Real-time PCR; electron microscopy.	6 3
	Extrinsic: renal transplantation.					

<i>Trichomonas vaginalis</i> (community)	Intrinsic: trichomoniasis.	-	-	-	RtMPCR.	6 4
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