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Patterns of antibiotic use and administration in hospitalized patients in Jordan

Anan S. Jarab [a,*], Tareq L. Mukattash [a], Buthaina Nusairat [a], Mohammad Shawaqfeh [b], Rana Abu Farha [c]

[a] Department of Clinical Pharmacy, Faculty of Pharmacy, Jordan University of Science and Technology, P.O. Box 3030, Irbid 22110, Jordan
[b] Department of Pharmacy Practice, College of Pharmacy, King Saud Bin Abdul-Aziz University for Health Sciences, Riyadh, Saudi Arabia
[c] Department of Clinical Pharmacy, Faculty of Pharmacy, Applied Science Private University, Jordan

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ABSTRACT

Background: Inappropriate use of antibiotics is the leading cause of emergence of resistance. It has been estimated that two million people in the United States had infection with resistant bacteria, resulting in 23,000 deaths annually. In Jordan, more than 50% of physicians prescribe antibiotics for inappropriate indication such as common cold, and approximately 67% of adult Jordanians believe that antibiotics should be used for this purpose. It is essential to follow antibiotics prescription guidelines in order to maximize effectiveness and enhance patient safety.
Objective: The study aim was to describe patterns of antibiotics prescription and adherence to guidelines of IV to oral antibiotic conversion in elderly patients visiting King Abdullah University Hospital (KAUH).
Methods: A retrospective cross sectional study was conducted on hospitalized patients who were prescribed IV antibiotics. Sociodemographic and clinical data in addition to a list of IV prescribed antibiotics was collected by referring to information technology department at KAUH. Patients' eligibility for antibiotic conversion from IV to oral route was then evaluated based on Society for Healthcare Epidemiology of America criteria.
Results: A total of 110 antibiotics were dispensed for 80 patients, imipenem/cilastatin was the most prescribed antibiotic (41.25%), followed by cephalosporines which were prescribed for 27.5% of the participants. Approximately half of the study patients (47.5%) were prescribed IV antibiotics despite their eligibility for oral conversion.
Conclusion: This study shows a shortage in the implementation of guidelines which are important to decrease antibiotic resistance and improving clinical outcomes. The clinical Pharmacist needs to be more involved in antibiotics prescription with the aim of improving effectiveness and decreasing potential antimicrobial resistance in hospital settings.

1. Introduction

Antibiotics have been used since the 1940s to treat patients who have infectious diseases, and have significantly contributed in morbidity and mortality reduction from these infections (Pollack and Srinivasan, 2014). When prescribing antibiotics, clinicians should necessarily take into account the correct diagnosis of the infection, potential risk of antibiotic resistance and existing resistance patterns, patient and drug characteristics, potential medication side effects, the difference between empiric and definitive antibiotic therapy, types of broad spectrum antibiotics and the switch to narrow spectrum ones, in addition to the costs of the prescribed antibiotics (Leekha et al., 2011).

Hospital-based programs have devoted the Antibiotic Stewardship Programs (ASPs) to improve and control antibiotics prescription and to optimize the quality of care of the infected patients. In 2014, all acute care hospitals were encouraged to conduct ASPs as recommended by Centers for Disease Control and prevention (CDC), an organization that is concerned in health issues in United States. The core elements of ASPs include: chief commitment,

accountability, drug expertise, action, tracking, reporting and education (Pollack and Srinivasan, 2014). Pharmacists play an important role in ASP, their responsibilities involve promoting the best utilization of antibiotics, decreasing the transference of infections and providing information about antibiotics for patients, health care professionals and the public (ASHP, 2010; Mertz et al., 2009).

The CDC (2015) estimated that 30% of antibiotics prescriptions in hospitals are inappropriate or unnecessary. Accordingly, new guidelines were released by the Infectious Diseases Society of America (IDSA) and Society for Healthcare Epidemiology of America (SHEA). These guidelines indicate that preauthorization of broad spectrum antibiotics and reviewing it prospectively after two or three days of the treatment form the cornerstone of ASP, with the aim of ensuring that the right drug is prescribed for the right indication at the right time (IDSA, 2016). In Jordan, more than 50% of physicians prescribe antibiotics routinely for treatment of common cold symptoms. Approximately, 67% of adult Jordanians believe that antibiotics are necessary for the treatment of common cold and cough (Shehadeh et al., 2012). However, when these antibiotics are used in wrong way, they will give a little benefit, lead to bad consequences and expose the patient to the risk of adverse events such as C. difficile infections, disruption of normal flora, development of antibiotic-resistant infections which may lead to the development of more severe diseases and complications and increase the length of hospital stay, in addition to the increase in mortality rates and health care costs (Hopkins, 2014; Llor and Bjerrum, 2014).

The concept of antibiotic resistance and misuse has been investigated in earlier studies in Jordan. A study was conducted to determine the prevalence of resistance in gram negative bacteria due to antibiotic use for patients admitted to the ICU at Prince Hashem Hospital showed that Pseudomonas aeruginosa was the most resistant pathogen, and there was an increase in the rate of broad-spectrum antibiotics resistance such as amikacin and piperacillin/tazobactam (Bataineh and Alrashed, 2007). Another study was carried out to evaluate the adherence to antibiotic prophylaxis guidelines in cardiac surgery department at Queen Alia Heart Institute (QAHI) reported non-adherence to guidelines of surgical prophylaxis and inappropriate antibiotics prescribing. The latter study highlighted the importance of clinical pharmacist involvement in the patient care process in order to improve the current antibiotics prescription and monitoring practice (Al-Momany et al., 2009).

Aim of the study

The aim of the study was to describe patterns of antibiotics prescription and adherence to guidelines of IV to oral antibiotic conversion in elderly patients visiting King Abdullah University Hospital (KAUH).

2. Methods

2.1. Study settings and subjects

The current cross-sectional study used a retrospective audit of inpatients who took IV antibiotics during the period from April 2017 through July 2017. The study was conducted in KAUH in Jordan, which is the largest hospital in the north of Jordan, serving about one million inhabitants from regions of Irbid, Mafraq, Ajloun and Jerash. It is also a teaching hospital that is linked to Jordan University of Science and Technology (JUST).

Inclusion and exclusion criteria were determined based on the IV to PO conversion rules. Patients were included if they were able to tolerate oral fluids and to absorb oral drugs sufficiently via oral,

feeding or nasogastric tube route. Patients were excluded if they were found to match any of the following criteria according to (1) absorption status including: age less than 18 years, status of no oral intake (NPO), requested bowel rest for fistula, suffered from inflammatory bowel disease, pancreatitis, or abdominal surgeries, had active gastrointestinal bleeding, had malabsorption syndrome such as obstruction, suffered from persistent nausea, vomiting or diarrhea, had motility disorder of the gastrointestinal system, shad hort bowel syndrome or gastroparesis. (2) Physical inability including: patients with risk of aspiration or inability to swallow unless the patient was able to take drugs via feeding tube, patients undergoing nasogastric (NG) suctioning continuously or had NG output more than 150 ml ≥2 times in a 24-h period, continuous tube feeds and patients who refuse to take oral medication. (3) Disease severity including Intensive care unit vasopressor dependents or those who are unstable hemodynamically, patients with decreased level of consciousness or seizures, immunocompromised patients, patients who suffer from life-threatening infection or serious disease state which needs full duration of IV drug such as central nervous system infection, bacteremia, osteomyelitis, endocarditis, septic arthritis, endophthalmitis, fungaemia or orbital cellulitis.

2.2. Data collection

By referring to information technology department in KAUH, a list of inpatients who took IV antibiotics in the period from April 2017 through July 2017 was obtained. A list of IV antibiotics that were used in the hospital was obtained from pharmacy department. Data were collected using data collection form which includes patient's file number, age, gender, height, weight, vital signs, WBC count, serum creatinine, type and the dosage regimen of the prescribed IV antibiotics in addition to the full medical history. Following data collection, the eligibility of each patient for conversion from IV to oral route based on SHEA criteria was evaluated.

2.3. Clinical criteria for IV to oral conversion

IV to PO antibiotics conversion is warranted if the patient: received >24 h of ordered IV antibiotics, showed an improving symptoms, had a confirmed clinical stability with the following parameters: negative cultures of blood for ≥48 h, stable or normal white blood cell (WBC) count and was afebrile i.e. temperature <100.4 °F (38 °C) for >24 h.

2.4. Ethical approval

After being approved by the research committee at the Faculty of Pharmacy in JUST, the study was approved by the Institutional Review Board (approval number 22-104-2017) at KAUH.

2.5. Statistical analysis

Simple descriptive statistics including percentages and means were used to describe the demographic and clinical characteristics of the study participants in addition to patterns of antibiotics prescription.

3. Results

During the study period, 11,998 patients were admitted to all wards of hospital. By excluding ineligible patients, 80 patients were found to be eligible for inclusion in this study. Half of the participants (50%) were female, (40%) aged more than 65 years (elderly), and the mean age was 57.2 (SD = 19.93). Majority of

Table 1
Characteristics of the study participants (n = 80).

Parameter	n (%)
Age	
<65 years	48(60)
≥65 years	32 (40)
Gender	
Female	40 (50)
Male	40 (50)
Body Mass Index	
Under weight (<18.5)	2 (2.5)
Normal (18.5–24.99)	21 (26.3)
Overweight (25–29.99)	28 (35.0)
Obese (≥30)	28 (35.0)
Creatinine clearance	
CrCl > 90 ml/min (stage 1)	19 (23.8)
CrCl (60–89) ml/min (stage 2)	17 (21.3)
CrCl (30–59) ml/min (stage 3)	29 (38.8)
CrCl (15–29) ml/min (stage 4)	8 (10.0)
CrCl < 15 ml/min (stage 5)	4 (5.0)

CrCl: reatinine clearence.

Table 2
Percentage of prescribed antibiotic per class (n = 80).

Antibiotic class	n (%)
Carbapenems	
Imipenem/Cilastatin	33 (41.3)
Meropenem	3 (3.8)
Ertapenem	2 (2.5)
Cephalosporines	
Ceftriaxone	20 (25.0)
Cefuroxime	2 (2.5)
Extended spectrum penicillin/Beta lactamase inhibitor	
Piperacillin/Tazobactam	16 (20.0)
Quinolones	
Levofloxacin	15 (18.8)
Nitroimidazoles	
Metronidazole	9 (11.3)
Glycopeptides	
Teicoplanin	4 (5.0)
Vancomycin	3 (3.8)
Aminoglycosides	
Amikacin	1 (1.3)
Gentamycin	1 (1.3)
Polymyxin E	
Colistin	2 (2.5)

the study participants (70%) were overweight (35%) and obese (35%). Regarding kidney function, 23.8% of the study participants had normal kidney function (CrCl > 90 ml/min), while the remaining had declined renal function with 5% of the participants were found to have end stage kidney failure without dialysis (CrCl < 15 ml/min). Table 1 illustrates demographic and clinical characteristics of the study participants.

Fig. 1 and Table 2, respectively describe the types of infections and antibiotics prescribed for the study sample. The most commonly prevalent infection was urinary tract infection (53.75%), followed by respiratory tract infection (23.75%), diabetic foot infection cases (8.75%), surgical site infection cases (6.25%) and cellulitis (3.75%). However, there was one pregnant case that had follicular tonsillitis, one postpartum female, and one case had spine osteomyelitis. A total of 110 antibiotics were dispensed for 80 patients, imipenem/cilastatin was the most commonly prescribed antibiotic (41.25%) followed by cephalosporines which were where prescribed for 27.50% of the participants. The most commonly prescribed antibiotic in UTI patients was imipenem/cilastatin (58.14%) followed by ceftriaxone (37.21%), while the most commonly prescribed antibiotic for respiratory tract infection was levofloxacin (78.95%) followed by piperacillin/tazobactam (36.84%). Findings revealed that 47.5% of the patients were

prescribed IV antibiotics although they were eligible for IV to oral conversion, and 36.25% of the patients were prescribed antibiotics without renal dose adjustments. Table 3 provides illustrations for the need to shift from IV to oral dosage forms, while Table 4 provides illustrations for inability to shift to oral dosage forms.

4. Discussion

The current study evaluates the appropriateness of antibiotic prescription and the implementation of IV to PO conversion guidelines in one of the largest hospitals in Jordan. The study findings reveal that a relatively high percentage (47.5%) of the patients were on IV antibiotics although they were eligible for IV to PO conversion. Approximately, one third (32.43%) of the patients who had urinary tract infections were not prescribed the appropriate antibiotics and 36.25% of the patients were prescribed antibiotics without renal dose adjustments. Such findings clearly demonstrate
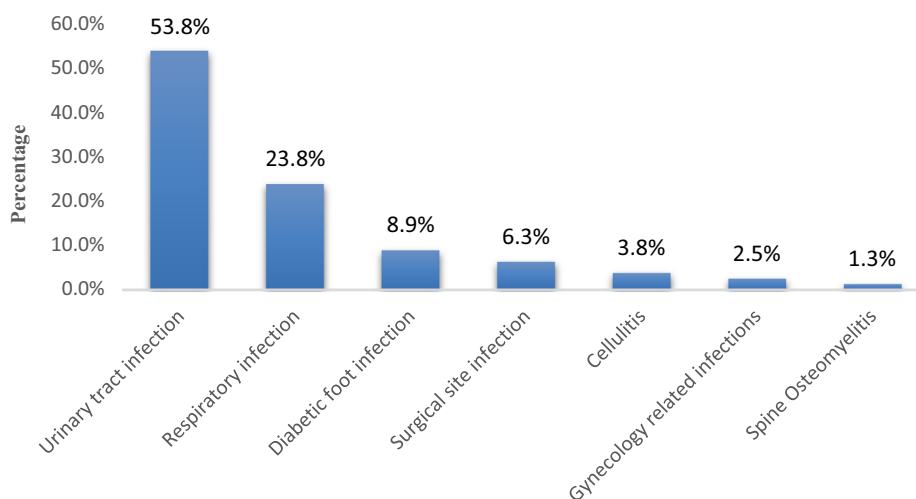

Fig. 1. Types of infection affected study patients.

Table 3

Illustrations and justifications for the need to shift from IV to oral dosage forms.

Case	Antibiotics	Justification for conversion to oral
Evaluation of elevated serum creatinine	Ceftriaxone 2 g IV q 24 h for 8 days	UA show no pyuria or bacteriuria at admission, Urine culture is negative, vitals are within normal, no previous admission or at home of taking ABX, so no need for IV ABX
Suspected uncomplicated pyelonephritis	Ceftriaxone 2 g IV q 24 h for 9 days	The patient had stable vitals without nausea or vomiting, afebrile, had history of prior hospitalization 4 days before discharged on ciprofloxacin, as a result UC was negative, can be treated as outpatient with trimethoprim/sulfamethoxazole for 14 days or given a short course of ceftriaxone, then converted to oral ABX
Suspected uncomplicated pyelonephritis	Ceftriaxone 2 g IV q 24 h for one day	Patient had flank pain, was afebrile, can tolerate oral intake, UA does not show pyuria, had not previous hospitalization or ABX intake, so the patient can be given ciprofloxacin or trimethoprim/sulfamethoxazole and no justification to give IV ceftriaxone
Complicated cystitis	Imipenem-cilastatin 500 mg IV q 8 h for 4 days	Patient admitted through outpatient clinic complain of dysuria, was clinically well, afebrile, with no previous ABX or admissions, UA showed abundant WBC, UC showed only heavy bacteria without sensitivity, can be treated as outpatient with oral ciprofloxacin
Complicated cystitis	Ceftriaxone 2 g IV q 24 h for 2 days	Patient had dysuria, UA showed WBC (0–2), no bacterial growth, had previous ABX intake before 20 days of ciprofloxacin Patient can be treated with oral trimethoprim/sulfamethoxazole
Puerperal infections (post-partum infection 10 days after delivery	Metronidazole 500 mg IV q 12 h, ceftriaxone 2 g IV q 24 h, gentamicin 80 mg IV q 12 h for 2 days	As Patient was afebrile, had normal WBC, UA showed mixed growth, vaginal swap was normal, patient can be converted to and treated with oral ABX (clindamycin)
Occipital pain for two months, malignant otitis externa, had left ear greenish discharge	Piperacillin tazobactam 4.5 g IV q 6 h, teicoplanin 200 mg IV once daily for 5 days	Culture of pus after three days showed no growth, and patient was vitally stable, so can be converted to oral ABX (ex, ciprofloxacin)
Complicated cystitis	Imipenem/cilastatin 500 mg IV q 6 h for 4 days	Patient was afebrile and vitally stable, had generalized abdominal pain, admitted due to positive UC without sensitivity, can be converted to oral ABX or started with it (oral ciprofloxacin), no previous ABX given at home
ESBL negative E. coli, uncomplicated pyelonephritis	Imipenem/cilastatin 250 mg IV q 6 h for 7 days	UC showed ESBL negative UTI, sensitive to ceftriaxone, trimethoprim, nitrofurantoin, so can be converted to oral ABX as its sensitive to oral one, or can be given ciprofloxacin
Uncomplicated pyelonephritis	Imipenem/cilastatin 500 mg IV q 6 h for 2 days, ceftriaxone 2 g IV q 24 h for 7 days	UA show abundant bacteria, UC showed heavy bacteria without sensitivity, although it was repeated 3 times with the same result (heavy bacterial growth), afebrile during hospitalization, can be converted to oral ciprofloxacin
ESBL negative E. coli, complicated cystitis	Ceftriaxone 2 g IV q 24 h for 4 days.	Patient admitted for evaluation due to suspected UTI, culture sensitivity showed ESBL negative sensitive to norfloxacin, ciprofloxacin, levofloxacin, cefazolin, and the patient was afebrile during hospitalization, can be converted to oral ABX, or given oral ciprofloxacin from beginning
Asthma exacerbation	Levofloxacin 500 mg IV q 24 h for 7 days.	Patient was afebrile, normal WBC, chest x ray showed left sided haziness, SO_2 at room air 95.8% upon admission, can be converted to oral levofloxacin
Complicated cystitis	Ceftriaxone 2 g IV q 24 h for 17 days	Elderly patient admitted to psychiatry unit, UA showed heavy with urinary symptoms, afebrile, after week of admission, UC showed no growth, patient can be converted to oral ABX once the culture was negative
Suspicion of lower respiratory tract infection	Ceftriaxone 1 g IV twice daily for 3 days	Patient had history of sore throat before admission and took ABX (azithromycin),vitals were normal, WBC normal, can be converted to oral ABX such as levofloxacin
ESBL negative UTI, complicated pyelonephritis	Imipenem/cilastatin 500 mg IV q 6 h for 7 days	UC showed ESBL –ve, sensitive to nitrofurantoin and ertapenem, no history of nausea or vomiting, afebrile, normal WBC, however can be treated with short course IV ABX, and then converted to oral ABX
Chest infection	Levofloxacin 500 mg IV once daily for one day	As the patient afebrile with normal WBC, can be converted from the beginning to oral levofloxacin
Chest infection	Levofloxacin 500 mg IV once daily for 8 days	Patient admitted due to SOB, chest infection vs Pulmonary Embolism, afebrile, normal WBC good O_2 on room air, so can be converted to oral levofloxacin
Pneumonia, patient had history of asthma	Levofloxacin 500 mg IV once daily, piperacillin/tazobactam 4.5 g IV q 6 h for 3 days	Vitals normal, WBC normal, can be treated as outpatient with oral levofloxacin
Asthma exacerbation, patient had asthma, not compliant to her medications	Levofloxacin 500 mg IV once daily for 5 days	Patient had normal vitals, not compliant to asthma medication, can be converted to oral levofloxacin
SOB, decompensated HF	Piperacillin/tazobactam 4.5 g IV q 6 h, levofloxacin 500 mg IV once daily for 2 days	As patient had decompensated heart failure, no justification for ABX, however can be converted to oral levofloxacin
SOB for 2 days PTA, patient admitted before one day to hospital due to decompensated HF, he had HF, COPD, CABG	Levofloxacin 250 mg IV once daily for 6 days	Vitals and WBC were normal during admission, can be given oral levofloxacin. However, his symptoms may be from decompensated HF

Table 3 (*continued*)

Case	Antibiotics	Justification for conversion to oral
Asthma exacerbation	Levofloxacin 500 mg IV once daily for 22 days	Patient's vitals and WBC were normal, however can be converted to oral levofloxacin, although the use of ABX in asthma exacerbation is controversial
Cellulitis, right leg cellulitis	Metronidazole 500 mg IV q 8 h, cefuroxime 750 mg IV three times daily for 4 days	No discharge or fever, normal WBC, can be treated as outpatient with oral cefuroxime and oral metronidazole
Prostatitis	Imipenem/cilastatin 500 mg IV q 6 h for 4 days	On the second day of admission patient was afebrile (also vitals upon admission was normal without fever, fever was documented only in the home), UA was normal on 24/3, UC later showed no growth, can be converted to ciprofloxacin on the second day
Diabetic ulcer infection	Teicoplanin 400 mg IV once daily for 8 days	Pus culture result in third day of admission showed MRSA sensitive to linezolid, vancomycin, teicoplanin, moxifloxacin, so can be converted to oral ABX as patient was afebrile and WBC was normal
Post orchidopexy for evaluation	Cefuroxime 750 mg IV q 8 h for 2 days	Patient has no urinary symptoms, vitally stable, admitted post orchidopexy for evaluation, can be converted to oral cefuroxime
Complicated cystitis	Piperacillin-tazobactam 2.25 g IV q 6 h for 5 days	Patient had no fever during and at admission, UA showed abundant bacteria, UC on third day showed no growth, WBC normal, no previous admissions or ABX given, can be converted to oral ciprofloxacin
Chest infection	Levofloxacin 500 mg IV q 24 h for 6 days	Patient's vitals were stable, no fever, no increase in WBC, he had right lung mass, can be converted to levofloxacin orally
Chest infection	Levofloxacin 500 mg IV q 24 h for 2 days	Patient had stable vitals, and normal WBC, can be converted to oral levofloxacin at admission
Diabetic foot infection	Imipenem/cilastatin 500 mg IV q 6 h for 6 days, piperacillin tazobactam 4.5 g IV q 6 h for 4 days	Pus culture in third day of admission showed P. aeruginosa sensitive to ciprofloxacin, otherwise vitals stable, WBC normal, can be converted to oral ciprofloxacin
For cystoscopy	Ceftriaxone 2 g IV once daily for 4 days	UA normal, UC normal, can be converted to oral ciprofloxacin, however cystoscopy as procedure need one dose of oral ciprofloxacin
For cystoscopy	Ceftriaxone 2 g IV q 24 h for 4 days	UA normal, UC normal, can be converted to oral ciprofloxacin, however cystoscopy as procedure need one dose of oral ciprofloxacin
Prostatitis	Ceftriaxone 2 g IV q 24 h for 3 days	Patient was vitally stable, WBC normal, UA at admission free of WBC and bacteria, UC free, can be converted at admission to ciprofloxacin or trimethoprim/sulfamethoxazole
Pneumonia	Piperacillin/tazobactam 4.5 g IV q 6 h, levofloxacin 500 mg IV once daily for 8 days	On fourth day of admission, patient was febrile, then after that there was no fever at all, WBC was normal, patient can be converted to oral levofloxacin on day 6
Kidney stone	Ceftriaxone 2 g IV daily for 5 days	At admission the UA was normal no pyuria or bacteriuria, patient vitally stable with other normal laboratory result, patient had only stone, can be converted to oral ciprofloxacin, however no justification for giving IV ABX
Thoracoscopy, patient has right lower chest pain for one month admitted for thoracoscopy (right lung cyst	Imipenem/cilastatin 500 mg IV q 6 h for 9 days	As the patient was vitally stable, afebrile during hospitalization, the chest pain was due to cyst, can be given oral levofloxacin, however no justification for IV ABX
Surgical site infection, after left hip replacement	Vancomycin 1g IV q12h for 10 days	Pus culture on third day showed no pathogen, vitally stable without fever, normal WBC, can be converted to oral vancomycin
Surgical site infection, after left total knee replacement	Vancomycin 1 g IV q 12 h for 11 days, piperacillin/tazobactam 4.5 g IV q 6 h for 4 days	Pus culture on third day showed staph epidermis sensitive to moxifloxacin, linezolid, clindamycin, teicoplanin, rifampin, vancomycin, as the patient was stable, normal WBC, can be converted to oral ABX

UA: urine analysis, ABX: antibiotic, UC: urine culture, WBC: white blood cell, ESBL: extended spectrum beta lactamase, UTI: Urinary tract infection, SOB: shortness of breath, HF: heart failure, PTA: prior to admission, COPD: chronic obstructive pulmonary disease, CABG: coronary artery bypass graft, MRSA: methicillin-resistant staph aureus.

the lack of the implementation of guidelines for antibiotics use and highlight the need for clinical pharmacists' involvement in antibiotics prescription for patients with different infectious diseases.

The CDC estimated that around 30% of antibiotics use in hospitals is inappropriate or unnecessary, and this will impede the achievement of desired outcomes and will expose the patients to the risk of adverse events including C. difficile infections and developing of antibiotic resistant infections (Hopkins, 2014). The application of ASP guidelines regarding the avoidance of antibiotics when appropriate or when they are indicated, and the use of appropriate selection and dose regimen, will increase clinical cure rates and decrease the toxicity and resistance (Abbo and Hooton, 2014).

The implementation of IV to PO conversion leads to a significant reduction in the length of hospital stay and the total duration of antibiotic therapy, in addition to catheter-related infections (Fernández-Morato et al., 2016). It has been approved that antibi-

otics with high bioavailability such as fluoroquinolones, both the IV and the oral routes resulted in similar cure rates (MacGregor and Graziani, 1997). Consistent with the current study findings, Ahkee et al. reported that 46% of the inpatients were treated with IV antibiotics although they were candidate for switch to oral therapy (Ahkee et al., 1997). According to a study conducted on patients with community acquired pneumonia who were given moxifloxacin, the conversion to oral antibiotics led to a decrease in antibiotics cost and an increase in the rate of success of clinical treatment (Davis et al., 2005). Another study regarding inpatients with community acquired pneumonia found that early switch from IV to oral third generation cephalosporine was clinically effective and reduced the hospital stay effectively (Ramirez et al., 1995).

Our study is the first study in Jordan that determines the adherence of IV to PO conversion rules. In summary, there is an urgent need to improve the clinical practice with regard to antibiotics use and administration via assuring the correct indication, doses

Table 4
Illustrations and justifications for inability to shift from IV to oral dosage forms.

Case	Antibiotics	Justification for inability of oral conversion
Diabetic foot infection	Metronidazole 500 mg IV q 12 h, piperacillin tazobactam 4.5 g IV q 6 h for 6 days	Sever infection for amputation
MDR UTI, complicated cystitis	Colistimethate sodium 1 million units q 8 h, amikacin250 mg once daily for 4 days	MDR P. aeruginosa sensitive only to IV amikacin and colistin
MDR UTI, complicated pyelonephritis	Piperacillin/tazobactam 4.5 g IV q 6 h for 3 days, metronidazole 500 mg IV q 8 h, meropenem 1 g IV q 8 h for 7 days	MDR organism sensitive only to IV meropenem and amikacin
ESBL + UTI, complicated cystitis	Ceftriaxone 2 g IV q 24 h for 3 days, imipenem/cilastatin 500 mg IV q 6 h for 4 days	UC showed ESBL + UTI, should be treated with IV ABX
Surgical site infection, surgical debridement after infection of femur after plate insertion	Imipenem/cilastatin 1 g IV q 6 h for 6 days	Sever infection
Spine osteomyelitis, patient has a history of extrapulmonary TB and multiple admissions	Imipenem/cilastatin500mg IV q6hours, teicoplanin400 mg IV q 24 h for 11 days	Serious infection should be treated with IV ABX
Surgical site infection after right hemiarthroplasty	Imipenem/cilastatin 500 mg IV q 6 h, colistin 2 million units IV three times daily for 35 days	Sever infection, culture showed MDR Acinetobacter sensitive only to colistin
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 250 mg IV three times daily for 6 days	Elderly patient had ESBL + klepsiella referred to hospital after a call for result of her UC done in outpatient clinic, sensitive to levofloxacin, ciprofloxacin, nitrofurantoin, ESBL +ve should be treated with IV carbapenem
ESBL + UTI, complicated cystitis	Ertapenem 1 g IV once daily for 3 days	ESBL +ve should be treated with IV carbapenem
Chest pain, shortness of breath for 4 months duration, had left sided plural effusion	Piperacillin/ tazobactam 4.5 g IV q 6 h for 7 days, levofloxacin 500 mg IV once daily for 10 days	Patient was clinically deteriorated and then became febrile
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 250 mg IV twice daily for 12 days	ESBL +ve should be treated with IV carbapenem
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 250 mg IV twice daily for 7 days	ESBL +ve should be treated with IV carbapenem
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 250 mg IV twice daily for 4 days	ESBL +ve should be treated with IV carbapenem
Tonsillitis, follicular tonsillitis, patient allergic to ceftriaxone	Levofloxacin 500 mg IV once daily, metronidazole 500 mg IV q 8 h for 2 days	Sever infection and the patient had difficulty swallowing.
Cellulitis of right hand and forearm	Teicoplanin 400 mg IV q12hours for the first 2 days, 200 mg once daily for the next 3 days, piperacillin tazobactam 2.25 mg IV q 6 h for 5 days	Patient was clinically deteriorated and became febrile
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 500 mg IV q 6 h for 3 days.	ESBL +ve should be treated with IV carbapenem
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 500 mg IV q 6 h for 4 days	ESBL +ve should be treated with IV carbapenem
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 250 mg IV q 8 h for the first 2 days, and 250 mg IV q 6 h for the next 2 days	ESBL +ve should be treated with IV carbapenem
Epididymitis, scrotal pain of mild to moderate severity without urinary symptoms	Ceftriaxone 2 g IV once daily for 2 days, imipenem-cilastatin 500 mg IV q 6 h for 5 days	Culture on third day showed ESBL +ve sensitive only to carbapenem.
Suspected complicated pyelonephritis	Imipenem-cilastatin 250 mg IV q 12 h for 5 days	A history of nephrolithiasis underwent left nephrectomy at 2 years old, patient had multiple admissions for recurrent UTI, should be treated with IV ABX.
ESBL negative UTI, complicated pyelonephritis	Imipenem/cilastatin 500 mg IV q6hours for 3 days	Culture sensitive to only IV ABX, and the patient on second day had a spike of fever
Diabetic foot infection	Imipenem/cilastatin 500 mg IV q 6 h for 6 days	Diabetic foot ulcer with pus sensitive only to IV ABX
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 250 mg IV q 6 h for 6 days	ESBL +ve should be treated with IV carbapenem
Diabetic foot infection	Imipenem/cilastatin 500 mg IV q 6 h for 2 days	Moderate to severe infection require IV ABX
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 500 mg IV q 6 h for 6 days	ESBL +ve should be treated with IV carbapenem
ESBL + UTI, complicated cystitis	Imipenem/cilastatin500 mg IV q 6 h for 6 days	ESBL +ve should be treated with IV carbapenem.
Wound infection, right groin wound infection post varicose vein stripping surgery	Piperacillin/tazobactam 4.5 g IV q 6 h for 8 days	High WBC at admission, 16000, however sever infection cannot be converted to oral ABX
Suspected complicated pyelonephritis	Ceftriaxone 2 g IV once daily for 6 days	Patient had multiple episode of vomiting, elevated WBC 12
Infected DM foot in left second toe, had ulceration, for amputation, culture showed ESBL +ve	Meropenem 1 g IV q 8 h, metronidazole 500 mg IV q 8 h for 6 days	ESBL +ve culture of diabetic foot infection need IV ABX.
Patient had chronic cough, pulmonary edema, admitted as Pulmonary embolism vs chest infection	Levofloxacin 250 mg IV once daily for 12 days	Patient clinically deteriorated and was put on JET nebulizer and migrated to ICU
Aspiration pneumonia, patient had history of chocking and difficulty swallowing, and decrease oral intake	Piperacillin/tazobactam 4.5 g IV q 6 h for 5 days, imipenem/cilastatin 500 mg IV twice daily for 10 days, meropenem500 mg IV three times daily for 10 days, levofloxacin 500 mg IV once daily for 7 days	Patient was clinically deteriorated and had difficulty swallowing
Complicated cystitis, ESBL + UTI	Ceftriaxone 2 g IV once daily for 3 days	Culture result on third day was ESBL +ve UTI, should be treated with IV carbapenem, but patient discharged
Bilateral foot ulcer, patient had DM	Piperacillin/tazobactam 4.5 g IV q 6 h, metronidazole 500 mg IV q 8 h for 4 days	Sever infection
Cellulitis and infected wound in left leg	Piperacillin/tazobactam 4.5 g IV q 6 h, metronidazole 500 mg IV q 8 h for 10 days	Sever infection
ESBL + UTI, complicated cystitis	Imipenem/cilastatin 500 mg IV q 6 h for 6 days	ESBL +veUTI, should be treated with IV carbapenem
ESBL + UTI, complicated cystitis	Imipenem/cilastatin500 mg IV q 6 h for 4 days	ESBL +veUTI, should be treated with IV carbapenem
Complicated cystitis P. aeruginosa, stone former, history of urethral implantation	Ceftriaxone 2 g IV once daily for 4 days	As the patient had history of urethral implantation, stone former, on third day of admission UC showed P. aeruginosa sensitive only for IV ABX

Table 4 (continued)

Case	Antibiotics	Justification for inability of oral conversion
Pneumonia diagnosed by imaging	Piperacillin/tazobactam 4.5 g IV q 6 h for 7 days, vancomycin 1 g IV once daily for 5 days, ceftriaxone 1 g IV q 12 h for 5 days	Patient was clinically unstable, and developed spikes of fever during admission
ESBL + UTI, complicated pyelonephritis	Imipenem/cilastatin 500 mg IV q 6 h for 7 days	ESBL +veUTI, should be treated with IV carbapenem.
Suspected complicated pyelonephritis	Ertapenem 0.5 g IV once daily for 4 days	Patient had previous admission before 3 days with same complaint and had ESBL +ve UTI sensitive to IV ertapenem
Pregnant with peritonsillar abscess, penicillin allergy	Metronidazole 500 mg q 8 h, ceftriaxone 1 g q 12 h for 4 days	Patient had difficulty swallowing cannot be converted to oral ABX
ESBL +ve complicated cystitis	Imipenem/cilastatin 500 mg IV q 6 h for 5 days	ESBL +veUTI, should be treated with IV carbapenem

MDR: multi-drug resistance, UTI: Urinary tract infection, ESBL: extended spectrum beta lactamase, UC: urine culture, TB: tuberculosis, ABX: antibiotic, WBC: white blood cell count, DM: diabetes mellitus, ICU: intensive care unit.

and route of administration, identifying patients who are candidate for switching to oral antibiotics in the appropriate time, and adjusting doses based on clinical characteristics of the patients. The optimal implementation of such duties requires the involvement of clinical pharmacist who is expert in infectious diseases scope. Furthermore, there is a need for periodic educational programs for healthcare professionals about antibiotics and their resistance and guidelines for optimal treatment of different infections.

Study limitations

The small sample size represents a major limitation of the current study and increasing the sample size could help withdrawing more robust conclusions from the current study. Furthermore, the study was not conducted in multiple centers which could limit the generalizability of the current study findings.

5. Conclusion

This study shows a shortage in the implementation of guidelines that are necessary to decrease antibiotics resistance and improving clinical outcomes. Clinical pharmacists should have a better understanding of antibiotics use and prescription guidelines in addition to improved awareness of antibiotics resistance concept. They should be more involved in antibiotics prescription practice with the aim of improving effectiveness and decreasing potential antimicrobial resistance in hospital settings. Future successful clinical pharmacy service programs should emphasize on the provision of optimal antibiotic therapy in order to improve health outcomes among hospitalized patients with different infectious diseases. Future research is needed to be implemented on patients with infections not investigated in the current study. Other studies are also needed to evaluate the clinical and economic impact of implementing ASP on hospitalized patients with different infections.

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Conflict of interest

None to declare.

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