Intravenous to Oral Conversion of Antibiotics Practice in Multidisciplinary Wards in Hospital Baling

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Received: 23 June 2024
Accepted: 30 May 2025

ABSTRACT

Introduction:

The conversion of intravenous (IV) antibiotics to effective oral (PO) formulations is a crucial element promoted in Antimicrobial Stewardship Program (ASP) activities. Early conversion practices offer numerous benefits, including fewer complications, reduced healthcare costs, and shorter length of hospital stay (LOS). This study aimed to determine the prevalence of switching from IV to PO antibiotics following criteria outlined in the IV-to-PO Antibiotic Switch Therapy Protocol, assess the duration of IV antibiotic administered and LOS, and assess the type of IV-to-PO conversion therapy being practiced.

Methods:

A cross-sectional study involving adult patients who received IV antibiotics from January to December 2021 in Hospital Baling, Kedah was conducted. Medical records of all patients who met the predetermined inclusion were reviewed.

Results:

Among 455 patients, approximately two-thirds (74.7%) were eligible for early conversion, yet only 48.5% of patients underwent timely conversion. Early conversion was statistically significant for pneumonia (P<0.001) and urinary tract infections (P=0.002). Amoxycillin-Clavulanate and Cefuroxime showed statistically significant differences in conversion practices (P<0.001). A shorter duration of IV therapy (3.06 ± 0.77 days) and LOS (4.29 ± 1.64 days) were observed in converted patients compared to non-converted patients (6.11 ± 1.29 days, 7.63 ± 2.78 days, respectively; P<0.001). Patients without COVID-19 showed a higher propensity for conversion therapy (OR=3.37, 95% CI 2.00–5.65). Sequential conversion therapy was predominantly employed (72.9%).

Conclusion:

A substantial number of eligible patients were not converted, despite the demonstrated benefits of conversion therapy in facilitating earlier discharge. Notably, the switch rate in pneumonia cases remained low, despite the significance of conversion practices. The conversion of Ceftriaxone achieved the lowest switch rate, warranting further attention. These findings underscore the need to strengthen conversion practices within ASP activities.

Keywords:

Conversion practice, intravenous to oral antibiotics, switch therapy, length of hospital stay, antimicrobial stewardship program

INTRODUCTION

Intravenous (IV) antibiotics have long been a cornerstone in the management of various types of infections, attributed to the traditional belief in their rapid delivery and high bioavailability. As a result, clinicians often prescribe them for both serious and non-threatening infections, despite its primary intention; for serious systemic infection patients.[1] However, the widespread utilization of IV antibiotics, particularly involving uncomplicated infections, raises concerns regarding overutilization, healthcare costs, and the risk of antimicrobial resistance. For instance, in uncomplicated cases such as skin and soft tissue infections (SSTIs), an early switch from IV to oral (PO) antibiotics was advocated.[2,3]

IV-to-PO antibiotic conversion practice is recognized as a valuable strategy for optimizing treatment outcomes and resource utilization in patients with common infections such as upper respiratory tract infections (URTIs), community-acquired pneumonia (CAP), and urinary tract infections (UTIs).[4-6] Eligibility for conversion therapy applies to approximately one-third of patients initially treated with IV antibiotics.[4,7] Early conversion to PO therapy can reduce the economic burden on the healthcare system by eliminating the need for ancillary supplies and minimizing pharmacy and nursing time.

A high rate of antibiotic conversion from IV to PO reduces the need for ongoing monitoring by clinical pharmacists. As key members of the Antimicrobial Stewardship Program (ASP), clinical pharmacists play a vital role in promoting the safe and rational use of antibiotics.[8,9] Importantly, this practice offers significant benefits to patients by reducing the risk of adverse effects associated with intravascular lines, such as catheter-related bloodstream infections and thrombophlebitis, as well as shortening the length of hospital stay (LOS).[10] The IV-to-PO antibiotic conversion practice has become an essential strategy in healthcare settings worldwide.

Antibiotic conversion therapy typically involves transitioning patients from IV to PO antibiotic administration. Several conversion therapies being employed in clinical practice, include sequential therapy, switch therapy, and step-down therapy.[11,12] The selection of a conversion therapy strategy depends on various factors, including the type and severity of infection, the patient's clinical status, antimicrobial susceptibility patterns, and healthcare facility resources. Each conversion

therapy approach has its advantages and considerations, aiming to optimize treatment outcomes while minimizing risks and healthcare costs.

In Malaysia, antibiotic usage has surged, leading to a rise in antibiotic resistance cases and a reduction in available antibiotic options. For instance, cephalosporins, the largest group of antibiotics, have seen increased utilization in later generations, as evidenced by a significant rise in the usage of second-line antibacterials such as cefepime and piperacillin/tazobactam.[13] ASPs have been introduced to address resistance issues and improve the appropriate use of antimicrobial agents. The conversion of IV antibiotic to an effective PO formulation is one of the crucial elements promoted in ASP activities. While IV antibiotics are necessary for severe infections or patients unable to tolerate PO medications, many infections can be effectively treated with PO antibiotics once the patient's condition stabilizes.

The IV-to-PO Antibiotic Switch Therapy Protocol, with stipulated criteria, serves as a guide for healthcare professionals in delivering appropriate antimicrobial management.[10] Guidelines and clinical pathways help clinicians identify appropriate candidates for conversion therapy and navigate the conversion safely and effectively. The optimal window for considering a conversion to PO therapy typically falls between 48 to 96 hours of IV treatment, particularly when supported by microbiology results.[10,12]

Numerous studies have provided robust evidence supporting the early conversion to PO antibiotics within the recommended period.[14-16] Importantly, such early switching has demonstrated equivalent treatment efficacy while avoiding adverse effects on patient outcomes. However, the implementation of conversion practices remains limited among healthcare professionals. Therefore, this study aimed to determine prevalence of current practices in switching from IV to PO antibiotics following criteria outlined in the IV-to-PO Antibiotic Switch Therapy Protocol, assess the duration of IV antibiotic administered and LOS, and assess the type of IV-to-PO conversion therapy practiced. Additionally, understanding the association between conversion practices and various clinical characteristics may support efforts to improve ASP activities.

METHODS

Study Design

This cross-sectional study was conducted at Hospital Baling in Kedah, Malaysia. All patients admitted to multidisciplinary wards at the hospital from January to December 2021 were eligible for inclusion. Patient information was obtained retrospectively from medical records and Pharmacy Information System (PhIS). The samples were selected using convenience sampling method.

Study Population

All adult patients given IV antibiotics were screened upon admission to multidisciplinary wards. However, patients transferred from tertiary hospitals for continued antibiotic treatment or those who transferred to a tertiary hospital were excluded. Additionally, patients requiring prolonged parenteral therapy for specific conditions were also excluded. These conditions included endocarditis, central nervous system infections (e.g., meningitis, brain abscess), *Staphylococcus aureus* bacteremia, osteomyelitis, septic arthritis, infected implants or prostheses, necrotizing soft tissue infections, melioidosis, deep-seated infections (e.g., abscesses, empyema), complicated orbital cellulitis, or liver abscess.

Sample Size

The sample size for this study was determined using the single proportion formula to estimate the prevalence of IV-to-PO antibiotic conversion practice. The calculation was based on a prevalence (p) of 0.40[4], a precision (Δ) of 0.05, and a 95% confidence level (Z = 1.96). After applying the formula, the initial sample size was determined and subsequently adjusted for a 15% dropout rate, resulting in a final required sample size of 435 participants.

Data Collection

A structured data collection form was developed, incorporating predefined eligibility criteria outlined in the Protocol on Antimicrobial Stewardship Program in Healthcare Facilities and the National Antimicrobial Guideline 2019.[12] The form was reviewed by the chief pharmacist and two medical officers from the ASP Team at Hospital Baling. Pre-testing was conducted to ensure completeness in covering important data and clarity. A total of 50 samples from the study period were selected for pre-test using convenience sampling. All data were collected by trained investigators using a standardized form to ensure consistency and reliability in data collection.

Data Analysis

The data analysis was conducted using SPSS version 26. Descriptive statistics were used to describe patient characteristics, with frequencies and percentages for categorical variables and mean and standard deviation (SD) for continuous variables. Statistical comparisons were conducted using chi-square tests to assess significant differences between the converted and not converted patient groups based on categorical variables such as indications for antibiotic use, types of antibiotics, and history of COVID-19. For continuous variables like duration of IV therapy and LOS, a one-way ANOVA test was applied. Statistical significance was determined based on a *P*-value <0.05.

Outcome Measurements

This study evaluated the current practice of converting IV antibiotics and its association with the history of COVID-19, indications for antibiotic use, and the type of antibiotic administered. It also examined the relationship between conversion practices, LOS, and the duration of IV antibiotics,

while assessing the eligibility for IV-to-PO conversion based on these factors and the type of conversion therapy employed in clinical practice.

The type of conversion therapy adopted in this study include sequential therapy, switch therapy, and step-down therapy.[10] Sequential therapy was defined as converting an IV antibiotic to its identical PO formulation. Switch therapy involved substituting an IV antibiotic with an PO antibiotic from the same class, maintaining a similar spectrum of activity whereas a step-down therapy transitioned IV antibiotics to PO antibiotics from a different class or to a different agent within the same class, which may vary in frequency, dose, and spectrum of activity.

Antibiotic switching is ideally performed between 48 and 96 hours of IV therapy, following the assessment of microbiological results and the patient's clinical response before transitioning to PO therapy. In this study, early conversion therapy was defined as IV-to-PO conversion occurring within the 72- to 96-hour review period, while prolonged IV therapy was classified as a minimum of five days of IV antibiotic treatment.

Patients were eligible for IV-to-PO conversion if they had received IV antibiotics for more than 48 hours and demonstrated the ability to tolerate oral therapy without compromised gastrointestinal absorption (e.g., absence of vomiting, diarrhea, malabsorptive conditions, unconsciousness, or swallowing difficulties). Evidence of clinical improvement were also required, indicated by a body temperature between 36–38 ℃, systolic blood pressure >90 mmHg, heart rate <100 beats per minute, respiratory rate <20 breaths per minute, white blood cell counts between 4×10^9 and 12×10^9 cells/L, and a downward trend in C-reactive protein (CRP) levels.

The IV-to-PO conversion was categorized into three groups: converted, not converted, and discontinued after a 72-hour review. However, only the converted and not converted patient groups were compared for statistically significant differences. "Converted" refers to patients who had successfully transitioned from IV to PO therapy, with early conversion occurring within 72–96 hours of IV treatment. "Not converted" indicated that the patient remained on IV therapy beyond the timeframe, while "discontinued" was defined as patients whose IV therapy was stopped within 72–96 hours without transitioning to PO therapy.

In this study, actual switch refered to whether patients who were transitioned from IV to PO therapy, irrespective of the timing. It did not specifically denote early conversion but merely confirmed that the switch has occurred. No actual switch indicated that IV therapy was either continued beyond the designated timeframe or discontinued before a transition to PO therapy could occur.

RESULTS

Sociodemographic data

Table 1. Patient baseline characteristics (n=455)

Characteristics	*n* (%)
Age[a] (years)	57.17 ± 19.31
Gender	
Male	244 (53.6)
Female	211 (46.4)
Race	
Malay	429 (94.3)
Chinese	13 (2.9)
Indian	4 (0.9)
Others	9 (2.0)
Discipline	
Medical	438 (96.3)
Surgical	4 (0.9)
Orthopaedic	13 (2.9)
Eligible for early switch	
Yes	340 (74.7)
No	115 (25.3)
Actual switch	
Yes	194 (42.6)
No	261 (57.4)
LOS[a] (days)	5.88 ± 2.76
Converted	4.29 ± 1.64
Not converted	7.63 ± 2.78
Discontinue	4.00 ± 1.22
Duration of IV antibiotics[a] (days)	4.52 ± 1.81
Converted	3.06 ± 0.77
Not converted	6.11 ± 1.29
Discontinue	3.40 ± 0.54
History of COVID-19	
Yes	51 (11.2)
No	404 (88.8)
Number of comorbidities	
No known medical illness	127 (27.9)
1	138 (30.3)
2	108 (23.7)
3	64 (14.1)
4	18 (4.0)
Types of comorbidities[b]	
Diabetes mellitus	157 (34.5)
Hypertension	181 (39.8)
COPD	40 (8.8)
Ischemic heart disease	40 (8.8)
Dyslipidemia	28 (6.2)
Chronic kidney disease	27 (5.9)
Bronchial asthma	26 (5.7)
Stroke	21 (4.6)
Heart failure	16 (3.5)
Atrial fibrillation	6 (1.3)
Malignancy	6 (1.3)
Thyroid disorders	4 (0.9)
ESRD	2 (0.4)
Seizure disorder	2 (0.4)
Others	27 (5.9)

[a]Data presented in mean ± SD; [b]The number of comorbidities involved was more than 455 as some patients had more than one comorbidities;
Abbreviations: COPD; chronic obstructive pulmonary disease, ESRD; end-stage renal disease

A total of 455 patients were included in the study. Malays constituted the largest population (n=429, 94.3%), and the mean age was 57.17 ± 19.31 years. The majority of patients receiving IV antibiotics were from the medical discipline (n=438, 96.3%), and almost half of them had two or fewer comorbid diseases, with hypertension (n=181, 39.8%) and diabetes mellitus (n=157, 34.5%) being the most common chronic diseases found in the population. Nearly three-quarters of the patients were candidates for conversion therapy (n=340, 74.7%). The mean LOS for converted patients was 4.29 ± 1.64 days, and the mean duration of IV antibiotic therapy for converted patients was 3.06 ± 0.77 days. Only 51 (11.2%) patients had a history of COVID-19 infections (Table 1).

Association between Conversion Practices and Various Characteristics

Overall, Amoxicillin-Clavulanate (n=197, 43.3% was the most commonly prescribed antibiotic, followed by Ceftriaxone (n=119, 26.2%) and Cefuroxime (n=64, 14.1%). Specifically, Amoxicillin-Clavulanate was frequently used for pneumonia (n=180, 75.3%), Ampicillin-Sulbactam for skin and soft tissue infections (SSTIs) (n=37, 62.7%), and Cefuroxime for urinaty tract infections (UTIs) (n=39, 68.4%) (Table 2).

Almost half of eligible patients received conversion therapy at 72-hour review (n=165, 48.5%). Cefuroxime was the antibiotic most commonly involved in conversion therapy among all eligible patients (n=32, 71.1%), followed by Ampicillin-Sulbactam (n=23, 60.5%) and Cloxacillin (n=6, 50.0%). However, only Amoxycillin-Clavulanate (Odds ratio = 4.19, 95% CI 1.87–9.37, *P*<0.001) and Cefuroxime (Odds ratio = 13.58, 95% CI 3.27–56.32, *P*<0.001) showed statistical significance in conversion practices. In contrast, Ceftriaxone (n=32, 36.8%) was least converted. Overall, 40 eligble patients (11.8%) were discontinued from IV antibiotics upon review at 72 hours (Table 3).

Patients with pneumonia (Odds ratio = 3.95, 95% CI 1.95–8.00], *P*=0.006) and UTIs (Odds ratio = 8.79, 95% CI 2.03–38.03, *P*=0.001) who were eligible for switch had a higher likelihood of IV-to-PO antibiotic conversion. Among all indications, UTIs (n=29, 69%) demonstrated the highest conversion rate. Additionally, the likelihood of conversion therapy was three times higher in patients without a history of COVID-19 (Odds ratio = 3.37, 95% CI 2.01– 5.65, *P*<0.001) (Table 3).

IV-to-PO conversion of antibiotic was not performed when C-reactive protein (CRP) was not trending down. However, it was carried out in some of the patients with persistent fever (n=1, 11.1%) and unstable immune response (n=26, 32.9%). The highest conversion rate was observed in patients presenting with tachycardia (n=30, 96.7%) and hypotension (n=14,100%) (Table 4).

Table 2. Indications of IV antibiotics use (n=455)

Antibiotics	Indications for antibiotic use, n (%)					
	Pneumonia	SSTIs	UTIs	Bacteremia[a]	Intra-abdominal infections	Others
Amoxicillin-Clavulanate	180 (75.3)	0 (0.0)	2 (3.5)	4 (50.0)	1 (16.7)	10 (11.6)
Ampicilllin-Sulbactam	1 (0.4)	37 (62.7)	7 (12.3)	1 (12.5)	0 (0.0)	3 (3.5)
Cefuroxime	15 (6.3)	4 (6.8)	39 (68.4)	1 (12.5)	1 (16.7)	4 (4.7)
Ceftriaxone	41 (17.2)	3 (5.1)	9 (15.8)	2 (25.0)	1 (16.7)	63 (73.3)
Metronidazole	1 (0.4)	2 (3.4)	0 (0.0)	0 (0.0)	3 (50.0)	6 (7.0)
Cloxacillin	1 (0.4)	13 (22.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

[a]Uncomplicated gram-negative bacteremia
Abbreviations: SSTIs; skin and soft tissue infections, UTIs; urinary tract infections

Table 3. Association between conversion practices with various characteristics (n=455)

Characteristics	Total, n (%)	Eligible for Switch, n (%)			Not Eligible for Switch, n (%)	*P*-value[a]	OR, (95% CI)[b]
		Converted	Not Converted	Discontinued			
Types of antibiotics use							
Amoxicillin-Clavulanate	197 (43.3)	68 (45.6)	65 (43.6)	16 (10.7)	48 (24.4)	<0.001	4.19 (1.87–9.37)
Ampicillin-Sulbactam	49 (10.8)	23 (60.5)	12 (31.6)	3 (7.9)	11 (22.4)	0.665	0.72 (0.16–3.22)
Cefuroxime	64 (14.1)	32 (71.1)	11 (24.4)	2 (4.4)	19 (29.7)	<0.001	13.58 (3.27–56.32)
Ceftriaxone	119 (26.2)	32 (36.8)	41 (47.1)	14 (16.1)	32 (26.9)	0.158	1.91 (0.77–4.71)
Metronidazole	12 (2.6)	4 (44.4)	3 (33.3)	2 (22.2)	3 (25.0)	0.151	-
Cloxacillin	14 (3.1)	6 (50.0)	3 (25.0)	3 (25.0)	2 (14.3)	0.197	-

Table 3. Continued

Characteristics	Total, n (%)	Eligible for Switch, n (%)			Not Eligible for Switch, n (%)	*P*-value[a]	OR, (95% CI)[b]
		Converted	Not Converted	Discontinued			
Indications for antibiotic use							
Pneumonia	239 (52.5)	74 (42.8)	78 (45.1)	21 (12.1)	66 (27.6)	<0.001	3.95 (1.95–8.01)
SSTIs	59 (13.0)	27 (56.3)	13 (27.1)	8 (16.7)	11 (18.6)	0.654	1.39 (0.33–5.77)
UTIs	57 (12.5)	29 (69.0)	11 (26.2)	2 (4.8)	15 (26.3)	0.002	8.79 (2.03–38.03)
Uncomplicated gram-negative bacteraemia	8 (1.8)	3 (50.0)	2 (33.3)	1 (16.7)	2 (25.0)	0.147	-
Intraabdominal infections	6 (1.3)	0 (0.0)	3 (75.0)	1 (25.0)	2 (33.3)	-	-
Others	86 (18.9)	32 (47.8)	28 (41.8)	7 (10.4)	19 (22.1)	0.508	1.43 (0.49–4.12)
History of COVID-19							
Yes	51 (11.2)	8 (24.2)	22 (66.7)	3 (9.1)	18 (35.3)	0.415	1.82 (0.41–7.99)
No	404 (88.8)	157 (51.1)	113 (36.8)	37 (12.1)	97 (24.0)	<0.001	3.37 (2.01–5.65)

[a]Pearson's chi-squared test for independence; [b]Odds ratio for converted and not converted groups
Abbreviations: SSTIs; skin and soft tissue infections; UTIs; urinary tract infections.

Table 4. Criteria that preclude the IV-to-PO conversion at 72 hours review (n=184)

Criteria	No. of patients, n	Conversion rate[a], n (%)
Fever	9	1 (11.1)
Unstable immune response	79	26 (32.9)
CRP trending down	5	0 (0.0)
Tachycardia	31	30 (96.7)
Hypotension	14	14 (100.0)
Tachypnea	3	1 (33.3)
Oral absorption is compromised	10	4 (40.0)
Not tolerate orally	4	3 (75.0)
No suitable oral alternatives	2	1 (50.0)
More than one criterion	27	17 (63.0)

[a]The conversion rate exceeded 100% as some patients fulfilled more than one criterion
Abbreviation: CRP; C-reactive protein

Types of Conversion Therapy

288 out of 455 IV antibiotic treatments (63.3%) were converted to PO therapy. Step-down therapy (n=52, 18.1%) and sequential therapy (n=210, 72.9%) were most frequently employed. Sequential therapy was commonly practiced in Ampicillin-Sulbactam (65.3%). Figure 1 shows that conversion therapy was least practised with Ceftriaxone (54.6%), followed by Metronidazole (41.7%) and Amoxicillin-Clavulanate (33.5%). Switch therapy demonstrated a shorter duration of IV antibiotic use (4.31 ± 1.32), compared to sequential therapy (5.01 ± 2.18) and step-down therapy (5.79 ± 2.28).

Duration of IV Antibiotics and LOS

The highest number of conversion therapy was observed on day 3 (n=115, 25.3%). However, almost half of the IV antibiotics were continued for 5 days or more before being converted to PO antibiotics (n=208, 45.7%), despite almost three quarters being eligible for early conversion therapy (n=152, 73.1%) (Table 5). A significantly shorter duration of IV antibiotic therapy was observed in converted patients (3.06 ± 0.773 days) compared to non-converted patients (6.11 ± 1.290 days) (P<0.001), highlighting the substantial impact of conversion practices on reducing IV duration.

Additionally, converted patients (4.29 ± 1.64) had a shorter LOS than non-converted patients (7.63 ± 2.78) (P<0.001). Patients who were not converted to PO antibiotics had a significantly longer IV duration. This is evidenced by the highest percentage (81.6%) of non-converted patients among those eligible for switch on day 7 of IV antibiotic therapy. One-way ANOVA was conducted to compare the three groups and revealed statistically significant differences in both mean LOS [$F(2, 452) = 125.65$, P<0.001] and mean duration of IV antibiotic therapy [$F(2, 452) = 474.42$, P<0.001]. However, there were no statistically significant differences between the converted and discontinued groups in IV antibiotic duration (P=0.11) or LOS (P=1.00).

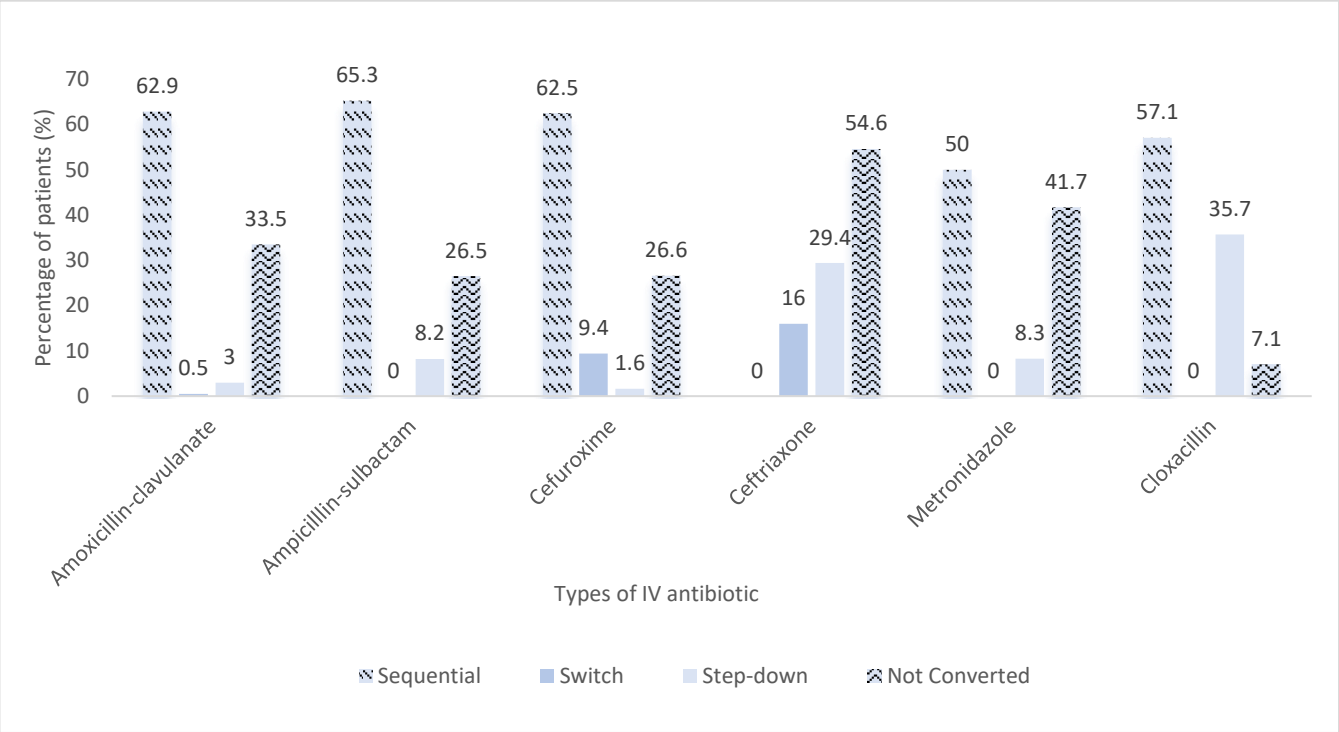

Figure 1. Conversion therapy in different types of antibiotics

Table 5. Timing of IV-to-PO conversion therapy and its conversion rate (n=455)

Duration[a] (days)	n (%)	Eligible for switch			Ineligible for switch		
		Switch[b], n (%)	Not switch[c], n (%)	Total, n	Switch[b], n (%)	Not switch[c], n (%)	Total, n
2	49 (10.8)	38 (95.0)	2 (5.0)	40	8 (88.9)	1 (11.1)	9
3	115 (25.3)	68 (80.0)	17 (20.0)	85	22 (73.3)	8 (26.7)	30
4	83 (18.2)	49 (77.8)	14 (22.2)	63	16 (80.0)	4 (20.0)	20
5	78 (17.2)	34 (59.6)	23 (40.4)	57	9 (42.9)	12 (57.1)	21
6	44 (9.7)	20 (62.5)	12 (37.5)	32	5 (41.7)	7 (58.3)	12
7	69 (15.2)	9 (18.4)	40 (81.6)	49	5 (25.0)	15 (75.0)	20
8	11 (2.4)	5 (62.5)	3 (37.5)	8	0	3 (100.0)	3
9	2 (0.4)	0	2 (100.0)	2	0	0	0
10	3 (0.7)	0	3 (100.0)	3	0	0	0
13	1 (0.2)	0	1 (100.0)	1	0	0	0

Notes: [a]Duration of IV antibiotic administered; [b]The IV antibiotics were converted to PO antibiotics; [c]The IV antibiotics were discontinued

DISCUSSION

Comprehensive data on the implementation of IV-to-PO antibiotic conversion practice in healthcare settings nationwide is still lacking, despite its advocacy as one of the crucial elements in ASP activities.[10] Unfortunately, only a few local studies have extensively explored antibiotic conversion practice.[4,14] This study is among the few conducted in a district hospital in Malaysia, where the service of physicians was not readily available in-house. The findings of this study can shed light on the issues associated with IV-to-PO antibiotic conversion practices in settings with limited access to physicians.

Only about half of the eligible candidates for conversion therapy underwent IV-to-PO antibiotic conversion, despite the absence of signs of infection, which was consistent with several other studies.[17,18] The exploration of factors influencing early conversion revealed that CRP levels, persistent fever, and an unstable immune response were associated with the lowest conversion rates. Additionally, Sevinç et al. identified concerns about inadequate PO drug concentrations at the infection site and patient intolerance to PO antibiotics as key barriers to conversion.[17] These findings highlighted the significant role of both clinical criteria and pharmacological considerations in determining early antibiotic conversion. Patients with high CRP, persistent fever, unstable immune response, or hemodynamic instability such as hypotension or tachycardia may require extended IV therapy for optimal management, as supported by national guideline and various studies.[12,19,20]

Despite early conversion therapy being statistically significant in patients with pneumonia, the conversion rate was low at only 42.8%, which was also observed by Deshpande et al..[21] Ramirez et al. found that patients with community-acquired pneumonia are safe for an early PO antibiotic conversion and early discharge without imposing risks on clinical outcomes, while attaining greater patient satisfaction and reducing healthcare

costs.[22] Furthermore, shorter IV antibiotic therapy, as short as 2 days, in non-severely ill patients with pneumonia was not inferior to prolonged IV antibiotic therapy for 10 days.[23] A meta-analysis also demonstrated early PO antibiotic conversion did not have a negative impact on mortality and recurrence rate in moderate to severe community-acquired pneumonia.[24] However, further research is warranted to address the disparity in conversion therapy for pneumonia.

In this study, early conversion practice is uncommon in uncomplicated gram-negative bacteraemia, as demonstrated by other studies. However, Tingsgård et al. observed that the 90-day all-cause mortality is comparable between patients with and without early conversion therapy.[16] This finding is further supported by several studies,[25,26] where early PO antibiotic conversion did not increase the risk of treatment failure compared to prolonged IV therapy. A systemic review and meta-analysis in uncomplicated gram-negative bacteraemia, showed that short-course antibiotic treatment yielded favourable outcomes.[27] Similarly, randomized controlled trials by Omrani et al.. demonstrated that early PO antibiotic conversion at 72-hour review displayed stable clinical response and was non-inferior to prolonged IV therapy.[28] Thus, incorporating an ASP has demonstrated a positive impact on the management of uncomplicated gram-negative bacteremia which included shortened treatment duration, promotion of early IV-to-PO conversion, and a reduction in readmission rates.[29]

None of the patients with intra-abdominal infections were converted to PO antibiotics in this study. Several randomized trials including intra-abdominal infections concluded that PO antibiotic therapy is as effective as IV therapy, advocating for the practice of conversion to yield favourable clinical outcomes.[30,31] Selänne et al. reported that PO antibiotic monotherapy showed non-inferiority compared to a combination of IV and PO antibiotics in the treatment of uncomplicated acute appendicitis.[32]

According to our findings, patients without COVID-19 infections showed a higher propensity for conversion therapy. The trend of initiating antibiotics empirically for bacterial co-infection in COVID-19 patients has been observed worldwide. However, it's worth noting that the incidence of bacterial co-infection in COVID-19 appeared to be low, consistent with findings from multiple studies worldwide.[33-38] Vaughn et al. found that nearly half of COVID-19-positive patients had their antibacterial therapy discontinued within one day of receiving a positive test result. Expanded testing capacity and faster COVID-19 PCR turnaround times are essential, as delays may have driven increased empiric antibacterial use.[38] Another multicenter study found that antibiotics were discontinued within 48 hours for the majority of COVID-19 patients without confirmed bacterial pneumonia.[39] This trend may be attributed to ASP initiatives emphasizing antibiotic reassessment at 48 hours, alongside increasing awareness of the prevalence of bacterial co-infections in COVID-19 patients. Besides, the absence of an admission white cell count > 8.2 × 10^6/mL and a reduction in CRP can aid in excluding bacterial co-infection and support the early cessation of antibiotics in nearly half of COVID-19 patients.[40] Therefore, it is imperative to review antibiotics at 72 hours to promptly de-escalate to PO antibiotics or discontinue antibiotic therapy to mitigate the risk of antimicrobial resistance.

In our findings, nearly half of IV antibiotics were continued for 5 days or more before being converted to PO antibiotics, despite patients not showing suggestive signs of infection. This trend is corroborated by several studies that demonstrated a higher conversion rate to PO antibiotics by day 3, mirroring our results closely.[14,41] Nguyen et al. have found that an early antibiotic switch within 72 hours did not compromise treatment outcomes for patients with SSTIs, yet offers significant advantages by reducing LOS and lowering treatment costs.[42] This suggests that implementing early switching protocols could be beneficial clinically and economically in the management of SSTIs. Oosterheert et al. also proved that early conversion of IV antibiotics on the third day could be safely implemented in patients with severe community-acquired pneumonia.[43] Sevinç et al. concluded that early conversion practice did not lead to negative outcomes, such as recurrence of infections or readmissions due to reinfection.[17] These findings support the idea that implementing early conversion protocols can be safely done in clinical practice without compromising patient outcomes.

Our study findings indicate that early IV-to-PO conversion had a positive impact on the LOS when comparing converted and non-converted patients. However, this conversion practice did not demonstrate a significant overall impact on LOS. Similarly, some previous studies have also reported no significant effect of conversion practice on LOS.[14,44] These findings underscore the importance of assessing the various factors that influence hospital stay duration. One study suggested that factors other than infection, such as concomitant medical conditions, contribute to prolonged hospital stays despite PO antimicrobial conversion.[44] Future research should investigate the underlying causes of prolonged hospitalization in the non-converted group and examine the clinical implications of shorter LOS in converted and discontinued patients. Better understanding of these patterns may help optimize patient management strategies, reduce healthcare costs, and improve overall patient outcomes.

Sequential and step-down therapy emerged as the most frequently employed method, which was similar to previous report findings indicating that Fluoroquinolones, Macrolides, and Metronidazole were commonly practiced for sequential conversion therapy. [14] However, it is important to note that while Metronidazole was prevalent in their study, it appeared to be one of the least practiced antibiotics in conversion therapy according to our findings. Ceftriaxone also posed a similar concern in conversion practice in our study, with more than half of patients remaining on Ceftriaxone until discharge, consistent with the findings by Wells et al..[45] This practice aligned with another finding conducted in Malaysia, regarding the use of Ceftriaxone in conditions such as leptospirosis, pneumonia, and cases of unknown origin.[46] This scarcity of conversion practice in Ceftriaxone could indeed be attributed to the unavailability of an PO formulation.[1,46] Since Ceftriaxone has no direct PO equivalent, its transition to an PO agent requires step-down conversion therapy.[14] This highlights the need for greater awareness and implementation of alternative step-down strategies when appropriate. These discrepancies suggest potential variations in clinical practices or patient populations across different settings or periods.

Limitations of the study

There are several limitations to the study. Firstly, the retrospective nature may have limited the depth of observation on clinical outcomes. Secondly, the absence of an investigation into the safety and efficacy of conversion therapy leaves a notable gap in understanding its overall impact on patient care. Thirdly, the study did not assess the potential cost advantages associated with conversion therapy, a crucial consideration in healthcare decision-making. Moreover, the presence of missing or incomplete data may have compromised the completeness and accuracy of the data collection process, potentially affecting the reliability of the study's findings. Lastly, the study did not consider the availability of healthcare facility resources, which could be a limiting factor in the implementation of conversion practices. These limitations highlight the necessity for future research to address these gaps and enhance study design and methodology.

CONCLUSION

This study succinctly addresses the persistent challenge of low conversion rates in ASP, particularly concerning pneumonia cases and the conversion of Ceftriaxone. Further investigation into the barriers impeding successful conversion practices is crucial for improving patient outcomes. Collaboration among ASP team members is indeed essential for developing tailored interventions to address these challenges effectively. Continued efforts to strengthen conversion practices within ASP activities will not only facilitate earlier discharge for patients but also contribute to combating antimicrobial resistance. The emphasis on further investigation and collaboration underscores a proactive approach toward enhancing ASP effectiveness.

ACKNOWLEDGEMENT

The authors would like to thank the Director of Hospital Baling and ASP of Hospital Baling for their support in this study. The authors also would like to extend their highest gratitude to the Director General of Health Malaysia for the permission to publish this article.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ETHICAL APPROVAL

This study was registered in the National Medical Research Registry (NMRR ID-22-01606A23) and was approved by the Medical Research Ethics Committee (MREC), the Ministry of Health Malaysia.

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