ORIGINAL ARTICLE

Clinicians' Knowledge, Beliefs and Acceptance of Intravenous-to-oral Antibiotic Switching, Hospital Pulau Pinang

S L Lee, MPharm, Sarriff Azmi, BPharm, Pharm D, P S Wong, MBBS, MRCP

Universiti Sains Malaysia, Clinical Pharmacy Discipline, School of Pharmaceutical Sciences, Minden, Bayan Lepas, Pulau Pinang 11800, Malaysia

SUMMARY

A cross-sectional study was conducted to explore clincians' baseline knowledge, practice beliefs and acceptance of intravenous (IV)-to-oral antibiotic switching practice in Hospital Pulau Pinang. The factors most highly rated for antibiotic conversion were the ability to maintain oral intake (85.6%) and microbiology etiology (85.0%). Majority of the clinicians (76%) agreed with the traditional clinical rule that "patient should be afebrile for 24 hours before IV-to-oral switch". Specialists and consultants had the highest knowledge score among the clinicians. However, they were generally less positive about a guideline being integrated into practice.

KEY WORDS:

Antibiotic switching therapy; clinicians beliefs; knowledge; acceptace; antibiotic switching practice guidelines

INTRODUCTION

The explosion of antimicrobial use has accounted for 9.7% (i.e. RM 6 million) of Hospital Pulau Pinang drug budget in 2009 [1]. With the current climate of economic restraints amidst large expenditures of intravenous (IV) antimicrobials, there has been mounting pressure from managed care organizations to reduce the use of IV antimicrobials [2]. Thus, one strategy is to discharge patients from the hospital as soon as patients' clinical conditions permit. In addition to the fact that antimicrobials have been prescribed in an uncontrolled fashion ever since the earliest years of anti-infective era, institutional policies for streamlining the use of antimicrobials all the more needed to be in place to ensure timely switch of parenteral to oral antimicrobials [3].

IV-to-oral antibiotic switching programs have been adopted in many countries way back in the 1990s. Ever since then, many studies have been carried out and had convincingly demonstrated the efficacy, safety and its economic impact of the program in the clinical institution [3-15]. Seeing the host of benefits that may be reaped from the program, it is woeful to know that IV-to-oral antibiotic guidelines are yet to be introduced into any of the ministry of health hospitals in Malaysia.

While many studies have been carried out to measure the impact of the switching therapy on hospital's finance, patient's comfort and satisfaction, very few studies have been conducted to provide a detailed description of the implementation process as well as to identify the barriers to implementation [2]. Therefore, this study, mainly to explore clinicians' baseline knowledge, practice beliefs and acceptance of the switching practice as well as to identify the reasons for not switching, will help understanding better how clinicians decide when to switch patients to oral dosing. The responses from the study will, too, serve as a primary and important source of reference prior to the implementation of IV-to-oral antibiotic policy in any Malaysian clinical institution.

MATERIALS AND METHODS

Study Site and Population

A cross-sectional survey study was conducted from December 15, 2010 through January 28, 2011 (Seven weeks) in Hospital Pulau Pinang which is a 1090-beded tertiary hospital and the main referral centre in Northern part of Malaysia. We surveyed all clinicians practicing general medicine, critical care, surgery, orthopaedic, obstetrics & gynaecology, paediatrics, oncology, neurology, opthalmology, cardiothoracic, acute care clinicians who were on duty during the study period. Doctors who were on mainly administrative duties were excluded. There were 422 potential subjects.

Data Collection Form

The survey questionnaire (in English) had six sections. The first section collected demographic data of the respondents, including age, gender, nationality, current position, specialty, the country in which the respondents obtained their basic qualifications, overseas practice experience and years in practice. Two questions in this section asked about the switching practice in their current area of practice.

The second section asked respondents to rate the importance of the given 13 clinical factors involved in deciding IV-to-oral antibiotic switch. They were identified in a previous study (16), which shares similar objectives with the current study, as important factors to the hospital discharge decision. These included vital signs, oral intake status, mental status and test results (white count, microbiology reports). Respondents rated each factor using a 5-point Likert scale, as very unimportant, unimportant, neutral, important and very important.

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Corresponding Author: Soo Lin Lee, Universiti Sains Malaysia, Clinical Pharmacy Discipline, School of Pharmaceutical Sciences, Minden, Bayan Lepas, Pulau Pinang 11800, Malaysia Email: lee.gsl@gmail.com

To better understand clinician practice beliefs, the third section asked the respondents to state the level of agreement to the given five clinical statements about the switching practice adapted from the similar study, referenced earlier in the second section [16], using another 5-point Likert scale (1, strongly disagree to 5, strongly agree). The clinical statements were modified based on inputs from an infectious disease expert, as the referenced study looked into the practice solely in managing pneumonia whilst the present study focuses on the antibiotic practice involving a wide range of infections of mild to moderate severity.

The fourth section comprised a checklist by which respondents were allowed to select the possible reason(s) identified in a previous study [2] as the main reasons clinicians continue patients on IV therapy. Respondents were also allowed to state their reasons if they were not already provided on the list.

The fifth section consisted of five questions to assess the clinicians' baseline knowledge about the switching practice. Respondents were requested to answer the first three questions based on a clinical scenario adapted from the literature [17], which is also commonly encountered in the local population; while the other two questions tested on the general knowledge in relation to antibiotic switching practice.

The sixth section consisted of a yes/no question, validated by an infectious disease expert, to examine whether the respondent would agree with the introduction of a switching guideline in the clinical practice. The 6-section questionnaire made up the three main domains that measure the clinicians' practice beliefs (section 2-4), baseline knowledge (section 5) and their acceptance (section 6) of the switching practice.

The questionnaire was face and content-validated. A pilot test was carried out with 24 clinicians for wording clarity and coverage of critical domains. An overall Cronbach's α coefficient of 0.845 was obtained, indicating good interitem reliability. Questionnaires were distributed to all clinicians through study investigators. Non-respondents received a replacement questionnaire booklet and a reminder in the form of a postcard two weeks later. A second reminder was disseminated to those who did not respond to the first reminder. At the seventh week, all completed questionnaires were assembled.

Analytical Methods

Statistical analysis package software, SPSS version 18.0 was used to analyse the data assembled. The differences of ratings for clinical factors and agreement to a set of practice statements among clinicians of various demographic characteristics were examined using Kruskal-Wallis and Mann-Whitney tests. Two-tailed P values of <0.05 were considered statistically significant. If stastistical significance was noted with Kruskal-Wallis test findings, post hoc analysis with Mann-Whitney test was conducted with Bonferroni correction. The same non-parametric tests were used to examine associations between categorical clinician variables and baseline knowledge scores, as the scores were skewed (i.e. Kolmogorov-Smirnov test, P<0.05). Chi-square test was used to evaluate the association between the grade of clinicians and the proportion of acceptance of a guideline in practice.

RESULTS

Response Rates and Clinicians' Characteristics

Two hundred and twenty one completed questionnaires were returned from the 422 eligible clinicians. Response rate achieved was 52.4%. Characteristics of the respondents are shown in Table I. The mean age of respondents was 30.5 ± 6.3 and the mean years of clinical practice was 5.05 ± 5.51. Nearly half of the poll respondents (45%) were house officers. One fifth of the clinicians (18%) practiced general internal medicine and other medical subspecialties. Over half of the clinicians (57.2%) obtained their basic qualification in Malaysia. One fifth of the clinicians (19.9%) had overseas practice at any one point in their career life. Over three quarters of the clinicians (86.0%) claimed that their department practiced IV-to-oral antibiotic switching. The mean time of switching in the past week was reported to be 4.29 ± 5.43.

Antibiotic Switching Decision

Table II shows the factors that clinicians rated as "very important" determinants in deciding when to switch patients from IV to oral antibiotics. The factors most highly rated were the ability to maintain oral intake (85.6%) and microbiology etiology (85.0%). The clinical features judged the least pertinent while deciding the swtich were the returning of blood pressure (44.3%) and oxygenation (48.9%) to baseline. Majority (76%) of the clinicians agreed with the traditional clinical rule that "patient should be afebrile for 24 hours before IV-to-oral switch". Fourty seven percents of clinicians agreed and 36% disagreed that"patient should receive a standard duration of IV antibiotic". A nearly equal proportion of clinicians agreed (27%), disagreed (36%) and (37%) were neutral about the belief that"white cell count should return to the reference range before IV-to-oral switch". As many as 69% of the clinicians agreed that "patients should not be switched if more than one of the following is present - heart rate (HR) ≥ 100 min, respiratory rate (RR) ≥ 20 BPM, blood pressure (BP) ≤ 100 mmHg, white blood cell <4 x 109/L or >12 x 109/L. Finally, over three quarters of the clinicians (84%) agreed that "oral route should not be compromised while considering the switch".

Differences in Clinical Factor and Practice Belief Ratings among Clinicians

There were significant differences between groups of clinicians according to grades for the opinion about the importance of a normalised white cell count. Post hoc analysis found that significant differences were noted between house officers and specialist/consultants (P=0.001, critical level of significance=0.017) as well as medical officers and specialists/consultants (P=0.010). However, there were no significant differences between house officers and medical officers on the same item. When clinical factor ratings were compared between clinicians that graduated locally and those from abroad, there were no significant differences for most of the items except for ratings of the ability to maintain oral intake, by means of which those that graduated abroad had higher ratings on this item. On a different note, clinicians

Table I: Demographic and practice characteristics of study respondents

Characteristics	Respondents	
	n	%
Physician Characteristics		
Gender		
Male	119	53.6
Female	103	46.4
Countries of Basic Qualification		
Malaysia	121	57.2
AbroadΩ	85	42.8
Mean Age, ±SD	30.51±6.30	
Practice Characteristics		
Current Position		
House Officer	100	45.0
Medical Officer	70	31.5
Specialist/ Consultant	52	23.4
Specialty		
Medical*	41	18.5
Surgery‡	25	11.3
Orthopaedic	27	12.2
O&G	36	16.2
Paediatrics†	30	13.5
Anaesthesiology	19	8.6
Trauma & Emergency	18	8.1
Others€	26	11.7
Mean years of practice, ±SD	5.05±5.51	
Overseas experience•, Δ	44	19.9
Departmental practice of IV-to-oral antibiotic switch	190	86.0
Mean times of IV-to-oral antibiotic switch in the past week, ±SD	4.29±5.43	

Ω Abroad includes countries such as USA, UK, Dublin (Europe), Canada, Taiwan, Australia, India, Indonesia, Egypt, Russia and Ukraine.
* Medical includes internal medicine and subspecialties such as cardiology, nephrology, infectious disease, rheumatology, endocrine, and neuromedical.
‡ Surgery includes general surgery and subspecialties such as vascular and paediatric surgeries.
† Paediatrics includes general paediatrics and subspecialties such as nephrology, oncology, critical care (i.e. paediatric ICU & neonatal ICU) and cardiology.
€ Others include specialties such as ophthalmology, oncology, cardiothoracic, neurosurgery, urology, plastic and reconstruction.
• With overseas practice refers to clinicians that had worked in countries such as Australia, New Zealand, UK, Dublin, USA, India, Indonesia, Singapore, Taiwan, Netherland, Turkey and Russia at any one point in the past while practicing as a clinician.
Δ Without overseas practice refers clinicians that had not worked in countries outside Malaysia at any one point practicing as a clinician.

Table II: Clinical factors rated as "very important" in deciding when to switch patients from intravenous to oral dosing

Clinical Factor	Percentage (%) rated as "very important"† (N=222)
Able to maintain oral intake	85.6
Microbiology etiology	85.0
No evidence of suppurative (i.e. pus-producing) infection	74.1
Temperature returned to normal	73.4
Comorbid conditions stabilized	70.6
General appearance	68.0
No positive blood cultures	66.0
White cell count returned to baseline	62.6
Heart rate returned to baseline	53.2
Mental status returned to baseline	51.8
Respiratory rate returned to baseline	50.0
Oxygenation returned to baseline	48.9
Blood pressure returned to baseline	44.3

† % rated as "very important" is obtained from "important" and "very important" responses grouped together to represent an overall agreement to each of the clinical factor listed above.

Table III: Comparisons of IV-to-oral antibiotic switching practice beliefs among clinicians of various specialties

Clinical Practice Statement	Mean∞ ± SD								Overall Mean±SD P value∂
	Medical* (N=41)	Surgery‡ (N=25)	Ortho (N=27)	O&G (N=36)	Paeds† (N=30)	A&E (N=18)	Anaes (N=19)	Others€ (N=26)	
Patients should be afebrile for 24 hours before IV-to-oral switch (Temperature >36°C and <38°C)	4.02±0.69	3.84±0.85	3.67±0.96	3.92±0.87	3.90±0.67	4.28±0.58	3.21±0.98	3.85±0.78	3.86±0.83 P=0.023[a]
Patients should always have a complete IV course of antibiotics as standard practice	2.61±1.07	2.92±1.41	3.89±1.09	3.08±1.13	3.34±1.08	3.72±1.18	3.63±1.01	3.56±0.96	3.26±1.18 P=0.000[b]
Patients should not be switched if more than one of the following is present- I. Heart rate ≥ 100 min II. Respiratory rate ≥ 20BPM III. Blood pressure ≤ 100mmHg IV. White cell count < 4 x 10^9/L or >12 x 10^9/L	4.12±0.87	3.76±0.97	3.78±0.80	3.83±0.66	3.34±0.97	4.00±0.87	3.84±0.90	3.65±0.80	3.80±0.87 P=0.026[c]
The white cell count should always return to the reference range before IV-to-oral switch	2.71±0.72	2.64±1.0	3.11±1.05	3.11±0.85	2.90±0.90	3.33±1.03	2.68±0.75	3.00±0.85	2.92±0.90 P=0.095
The oral route should not be compromised when considering IV-to-oral switch	4.20±0.90 P=0.902	4.08±0.88	4.11±0.80	4.14±0.72	4.11±0.99	4.00±1.03	3.95±0.91	4.31±0.74	4.13±0.86

∞ Clinicians were asked to rate the extent of agreement and disagreement to the 5 clinical statement above as- 1-Strongly disagree; 2-Disagree; 3-Neutral; 4-Agree; 5-Strongly Agree. The mean presented is an average measure based on responses from the clinicians according to specialties.
* Medical includes internal medicine and subspecialties such as cardiology, nephrology, infectious disease, rheumatology, endocrine, and neuromedical.
‡ Surgery includes general surgery and subspecialties such as vascular and paediatric surgeries.
† Paediatrics includes general paediatrics and subspecialties such as nephrology, oncology, critical care (i.e. paediatric ICU & neonatal ICU) and cardiology.
€ Others include specialties such as ophthalmology, oncology, cardiothoracic, neurosurgery, urology, plastic and reconstruction.
∂ Data were analyzed using Kruskal-Wallis test. P values presented are for overall comparisons between clinicians of various specialties.
a Medical versus anaesthesiology clinicians P=0.001, anaesthesiology versus trauma & emergency clinicians P=0.001 (Critical level of significance, 0.0018)
b Medical versus orthopaedic clinicians P<0.001, Medical versus anaesthesiology clinicians P=0.001, Medical versus other clinicians P=0.001 (Critical level of significance, 0.0018)
c Medical versus paediatric clinicians P=0.001(Critical level of significance, 0.0018)

Table IV: Differences in baseline knowledge scores∞ among clinicians of various characteristics

Categorical Clinician Variables	n	Total Knowledge Score Mean (SD)	Range	Total Knowledge Score Median	Interquartile Range	P Value
Gender	206	3.52 (1.25)	0-5	4.00	2.00	P=0.068♦
Male	114	3.36 (1.32)	1-5	3.00	3.00	
Female	92	3.71 (1.12)	0-5	4.00	2.00	
Current Position	206	3.52 (1.25)	0-5	4.00	2.00	P=0.001[a,b]
House Officer	90	3.18 (1.26)	1-5	3.00	2.00	
Medical Officer	67	3.66 (1.25)	0-5	4.00	2.00	
Specialist/ Consultant	49	3.94 (1.09)	1-5	4.00	2.00	
Specialty	206	3.52 (1.25)	0-5	4.00	2.00	P=0.160[a]
Medical*	38	3.95 (1.31)	1-5	4.50	2.00	
Surgery‡	22	3.50 (1.50)	1-5	4.00	3.00	
Orthopaedic	27	3.52 (1.89)	1-5	4.00	2.00	
Obstetrics & Gynaecology	33	3.25 (1.30)	0-5	3.00	2.00	
Paediatrics†	29	3.24 (1.24)	1-5	3.00	1.00	
Anaesthesiology	18	3.33 (1.08)	1-5	3.00	1.00	
Trauma & Emergency	15	3.87 (0.92)	2-5	4.00	2.00	
Others€	24	3.46 (1.10)	1-5	4.00	1.00	
Country of Basic Qualification	206	3.52 (1.25)	0-5	4.00	2.00	P=0.648♦
Malaysia	121	3.54 (1.28)	0-5	4.00	2.00	
AbroadΩ	85	3.48 (1.21)	1-5	4.00	1.50	
Overseas Practice	206	3.52 (1.25)	0-5	4.00	2.00	P=0.034♦
Yes•	41	3.90 (1.09)	1-5	4.00	2.00	
NoΔ	164	3.43 (1.29)	0-5	4.00	1.00	
Departmental Practice	206	3.52 (1.25)	0-5	4.00	2.00	P=0.647♦
Yes	179	3.50 (1.26)	0-5	4.00	2.00	
No	26	3.65 (1.13)	1-5	4.00	2.00	

∞ Baseline knowledge score is an aggregate measure based on responses to the 5 questions in relation to IV-to-oral antibiotic conversion practice. The total score is 5. Scores range from 0-5. See methods section about the construction. Scores for 16 respondents were unable to compute due to partly missing data.
* Medical includes internal medicine and subspecialties such as cardiology, nephrology, infectious disease, rheumatology, endocrine, and neuromedical.
‡ Surgery includes general surgery and subspecialties such as vascular and paediatrics surgeries.
† Paediatrics includes general paediatrics and subspecialties such as paediatric nephrology, oncology, critical care (i.e. paediatric ICU & neonatal ICU) and cardiology.
€ Others include specialties such as ophthalmology, oncology, cardiothoracic, neurosurgery, urology, plastic and reconstruction.
Ω Abroad includes countries such as USA, UK, Dublin (Europe), Canada, Taiwan, Australia, India, Indonesia, Egypt, Russia and Ukraine.
• With overseas practice refers to clinicians that had worked in countries such as Australia, New Zealand, UK, Dublin, USA, India, Indonesia, Singapore, Taiwan, Netherland, Turkey and Russia at any one point in the past while practicing as a clinician.
Δ Without overseas practice refers clinicians that had not worked in countries outside Malaysia at any one point practicing as a clinician.
♦ Mann-Whitney U test. Kolmogorov-Smirnov test output showed that the data were significantly different from normal distribution. P<0.05. Thus, non-parametric test was used.
a Kruskal-Wallis test. Kolmogorov-Smirnov test output showed that the data were significantly different from normal distribution. P<0.05. Thus, non-parametric test was used.
b House officer versus medical officers P=0.013, house officers versus specialists/consultant P=0.001 (Critical level of significance, 0.017)

Table V: Association between the grade of the clinicians and the acceptance of the implementation of an IV-to-oral antibiotic switching guideline

	Acceptance of an IV-to-oral antibiotic switching protocol/guideline (Percentage of Clinicians∞, %)		
Grade of Clinicians	**Yes**	**No**	**P Value[a]**
HO*	96.9	3.1	0.005
MO†	94.2	5.8	
Specialist/Consultant	82.7	17.3	

∞ Respondents were asked to answer a yes/no question to examine whether they would agree with the introduction of an IV- to-oral antibiotic conversion protocol in the clinical setting.
* HO indicates house officer
† MO indicates medical officer
a Data were analyzed using Chi-square test.

who had practiced merely locally (i.e. without overseas practice) were noted to have higher ratings for the absence of positive blood cultures (P=0.019) and a normalised white cell count (P=0.022) for antibiotic switching decisions.

Differences in practice beliefs among clinicians of various specialties are displayed in Table III. There were significant differences among clinicians for three of the five clinical practice statement ratings. Post hoc analysis revealed that significant differences for the agreement that "patient should be afebrile for 24 hours before IV-to-oral switch" were between clinicians of medical and anaesthesiology specialties (P=0.001) as well as clinicians of anaesthesiology specialty and acute care (P=0.001, critical level of significance = 0.0018). There were also significant differences on the statement that "patients should always complete IV course of antibiotics as a standard practice" between medical and orthopaedic clinicians (P<0.001), medical and anaesthesiology clinicians (P=0.001) as well as medical and other clinicians (P=0.001, critical level of significance = 0.0018). Also, significant differences were noted between medical and paediatric clinicians for ratings of the agreement that "patient should not be switched to oral antibiotics if HR ≥ 100 min, or RR ≥ 20 BPM, or BP ≤ 100 mmHg or white cell count < 4 x 10^9/L or >12 x 10^9/L is present (P=0.001, critical level of significance, 0.0018).

Reasons for Continuing IV Therapy

Clinicians were surveyed to identify the reasons they would prefer to continue patients on IV therapy. These include: clinical instability of the patient (88%); uncertainty about gastrointestinal function (58%); uncertainty as to whether the oral alternatives achieve effective tissue levels (57%); reassurance that IV treatment achieves effective tissue levels (56%); uncertainty about availability of oral alternatives (41%); liability for unsuccessful treatment outcomes (31%) and others (1.4%).

Comparisons of Baseline Knowledge Scores among Clinicians of Various Characteristics

The differences of baseline knowledge scores among clinicians are displayed in Table IV. The median total knowledge score was 4.0. Significant differences in the knowledge scores were observed between clinicians who had and those who had not practiced clinically abroad (P=0.034). Also, there were significant differences in the scores among groups of clinicians according to grades by which post hoc analysis showed that the differences were noted between house officers and specialists/consultants (P=0.001) as well as house and medical officers (P=0.013, critical level of significance=0.017). However, there were no significant differences among clinicians of different genders, speacialties, place of graduation and departmental practice (P>0.05).

Clinicians' Acceptance of IV-to-oral Antibiotic Switching Guidelines

Of clinicians' acceptance of an IV-to-oral antibiotic switching guideline in practice, 92.7% agreed with such initiative. However, 7.3% of them disagreed with it. Reasons of objection include possible patient's clinical instability due to neutropenic sepsis and surgeries, dubious bioavailability and efficacy of oral preparations in critically ill patients and disapproval of abiding by a rigid guideline when treatment should be individualised according to patient's needs and concerns. Statistically, it was noted significantly that specialists/consultants were generally less positive about a guideline being incoporated into practice than would a house or medical officer (See Table V).

DISCUSSION

The judgement about the timing of switch from IV to oral antibiotic is crucial to the inpatient management of mild to moderate infections. Patients are normally discharged within a day or so following switching, provided that they have no active complaints that may prolong stay. Therefore, the switch timing is a major determinant of the length of hospital stay, hence, the total cost of healthcare. This study explored clinicians' knowledge, beliefs and acceptance of IV-to-oral antibiotic switching practice. Insights from this survey will serve as a guide to devise the suggested guideline as well as to introduce corresponding reinforcement strategies.

The clinicians identified the ability to maintain oral intake, microbiology etiology, absence of suppurative infection and a normal temperature as the most important clinical determinants in deciding when to switch patients from IV to oral antibiotics. These were found to be consistent with the previous work by Halm *et al* [16] that identified the same factors as those found in the current study with the addition of normalisation of RR, oxygenation and mental status that were found only moderatly rated in this study. The results from the present study were not wholly in accordance with another prior work where abnormalities in vital signs, ability to maintain oral intake and mental status were shown to be vital indicators for judging overall clinical stability in penumonia [18-19]. The inconsistency of the findings could possibly be ascribed to the different focus of the studies, whereby the current study focused on a broad range of mild to moderate infections in contrast to the prior works which center only on community acquired pneumonia (CAP).

The differences we observed for clinical factor ratings among clinicians of various grades were intriguing. There was a general consenses among clinicians about the importance of most of the clinical factors for switching decision except in the case of a normalised white cell count, whereby specialists/consultants were found to have a lower rate on this item. This probably suggests that specialists/consultants would treat patients based on clinical judgment rather than to be tied down to the traditional teaching about the importance of a normalised white cell count that lacks supportive evidence [16]. It is not surprising that they would take into account of other patient-specific factors before any antibiotic is prescribed, possibly, owing to their longer years in clinical practice or specialisation. This rationalisation is, however, contradictory to the findings reported previously that clinicians with more years in practice are inclined to hold on to more traditional practice beliefs [16, 20]. Our survey also identified that clinicians who graduated abroad will be more likely to take into consideration of the ability to maintain oral intake upon determining patient's eligibility for switching. On the contrary, clinicians that had not practiced abroad before tend to perceive the absence of positive blood

cultures and the returns of white cell count to baseline as more important indicators for switching decision. This could possibly imply that overseas and local teaching and practice could have different emphasis on the above-mentioned factors for such switching practice.

Majority of the clinicians are of the same opinion with the traditional clinical rule that patient should be afebrile for 24 hours before IV-to-oral switch. This finding is not astounding and it is in accord with study findings by Halm *et al* [19] indicating that the risk of subsequent clinical deterioration critical enough to require intensive care was minimal once overall stability (which includes temperature ≤38°C or 101°F or less) is achieved. With that, they concluded that it would be safe to switch to oral antibiotics once patients are clinically stable for 24 hours and allow discharge shortly thereafter provided that there are no active complaints [19]. That is not all, a previous study on pneumonia [21] and another on pyelonephritis [22] had demonstrated that patients are not likely to experience a decrement in the quality of care if they were to be discharged right after the switch. While three quarters of clinicians in the current study agreed with the rule, 15% of them disagreed with it. This could possibly suggest that this small proportion of clinicians do not wholly agree with the timing or the explicit temperatures that were stated (or both) before which the switch could be performed.

The differences of beliefs noted among clinicians of various specialties were fascinating. The overall trend observed was that medical specialty clinicians are relatively more inclined to hold the belief that patients should be afebrile for 24 hours prior to the switch as compared to their anaesthesiology colleagues. This could possibly be explained by the field nature of anaethesiology. Clinicians in this area of practice possibly manage more complicated and life-threatening cases by which other clinical factors besides temperature may need to be taken into account for antibiotic switching. In addition to that, absorption of oral antibiotics is a main concern for patients in critical care setting as these patients would have a compromised gut function.

Our study discovered other barriers to practicing antibiotic switching therapy. Nearly half of the clinicians felt that patients should always have a complete IV course of antibiotic as a standard practice. This conventional practice is unwarranted for mild to moderate infections on the grounds that a few studies have shown that short courses of IV therapy are safe and effective, especially for pneumonia [11, 23] and urinary tract infections [24]. Also, with the introduction of more and new oral antibiotics coupled with enhanced bioavailability, this allows achievement of satisfactory serum drug level in the shortest time possible (provided that gastrointestinal tract is functional for optimal absorption) [16]. Interestingly, the study findings revealed that clinicians of medical specialty seemed to be less predisposed to agree that patients should always complete IV course as a standard practice. On the contrary, clinicians in the area of practice that requires surgical procedures (i.e. orthopaedic, cardiothoracic, neurosurgery, etc) are more inclined towards continuation of IV antibiotics. It could be explained by the fact that post-surgery patients may not be all appropriate for oral antibiotics [25]. This was seconded by a kinetic study by which oral bioavailability of ciprofloxacin was found to be reduced for peritonitis surgery patients [26]. This study suggests that major surgery may impair absorption of ciprofloxacin, however, more studies using different antibiotics are required to clarify this issue.

In the present study, there was a general agreement about what constituted stable vital signs for the purpose of conversion. Two thirds of the clinicians agreed that patients should not be converted to oral antibiotics if one of the following vital signs for clinical instability is present. These include HR ≥ 100 min, RR ≥ 20 BPM, BP ≤ 100 mmHg or white cell count < 4 x 10^9/L or >12 x 10^9/L. In a study by Halm *et al* [19], it was discovered that, for a range of definitions considered for CAP, the risk of subsequent deterioration is minimal once a patient had stabilised. Nevertheless, there were still a minority of clinicians, in the current study, who did not agree with the clinical thresholds for instability, particularly the paediatric clinicians. This could be due to the fact that a different set of criteria could have been adopted for managing paediatric cases, due to their varying pharmacokinetic profiles. Besides, in the area of antibiotic switching, paediatric studies have been scant and lacking [27]. However, it is as yet pertinent that clinicians come to an agreement about a minimum standard set of criteria for antibiotic switching as Halm *et al* [19] also intriguingly found that different definitions of stability can bring about greater than two-fold differences in the target length of stay.

The equal proportion of clinicians agreeing and disagreeing to the belief that white cell count should return to the reference range before IV-to-oral switching could be performed was only bewildering. In fact, a normalised white cell count has never been independently associated with mortality in the case of CAP, though it is a sensible physiological marker of infection [16, 18]. Most of the guidelines have, too, specified that switching could be considered if the white count is trending downward (i.e. normalising) as this may signify that patient's inflammatory response associated with the infection is declining [17]. However, more studies needed to be conducted to verify this finding in infections other than CAP.

Over three quarters of the clinicians recognised patients' clinical instability as one of the main reasons that they would continue patients on IV antibiotics. This is consistent with the study finding by Wong-Beringer *et al* [2] by which it was also rated as the primary reason for IV continuation. In view of this, patient eligibility criteria for switching should be prudently developed to assure appropriate patient selection [28]. Slightly over half of the clinicians were uncertain about whether oral alternatives would achieve effective tissue levels should switching ever be performed (57%) and they were reassured that IV treatment would achieve effective tissue levels as compared to oral alternatives (56%). The similar proportion of clinicians agreeing to these two reasons suggests that clinicians, too, hold an inevitable notion that IV antibiotics are better than the oral ones, in the same way it was described by Cunha in his review article [29]. Nonetheless, such belief is understandable as data about the bioavailability of selected oral antibiotics in hospitalised patients and those in selected populations, remarkably in paediatric patients are

still lacking [27-28]. More than half of the clinicians felt that being uncertain about patients' gastrointestinal function is one of the factors limiting antibiotic switch. This is essentially an important aspect to be taken into consideration upon deciding switching as far as absorption of medications is concerned. This is because, as Wetzstein 3 had mentioned, patients with unreliable response to oral medication are not considered candidates for switching. This is to avoid treatment failure, should it ever occur, which may easily cost more than the money that could be saved from the switching program [30]. Slightly under half of the clinicians justified that their uncertainty about the availability of oral alternatives has, to some extent, impeded them from switching IV to oral dosing. This issue could be solved by establishing formularies and providing face-to-face and over-the-phone information by the clinical pharmacists.

Our study revealed that clinicians' gender, specialty training, country of graduation and departmental practice do not impinge in their knowledge about antibiotic switching practice. It was not astonishing that specialists/consultants tended to be more familiar with the practice principles (reflected in their higher knowledge scores) as compared to medical and house officers, possibly, owing to their longer years of clinical experience. Seeing that medical and house officers have lower mean total knowledge scores, more educational strategies need to be taken up to heighten their level of awareness and reinforce their knowledge on such practice. Guidelines are "good educational tools" that may be most beneficial to users with limited experience and expertise [31-32]. It was not surprising that clinicians who had practiced overseas at any one point in their career life scored better than those who had not done so as such switching practice has long been adopted in countries such as Canada, US and UK for cost containment purposes as well as for the promotion of judiscious use of antibiotics.

The reasons given by the small proportion of clinicians who objected the idea of antibiotic switching guideline implementation were acceptable as those are some of the factors that need to be taken into consideration while deciding definite criteria of patient eligibility for switching. Seeing as the encouraging response as a whole in regards to guideline implementation, it would be practical to provide one with succinct criteria agreed by local groups of clinicians to define appropriateness for the switch. However, this is not a "one size fits all" approach. Guidelines should always be looked upon as advisory rather than obligatory tools to guide clinicians towards the best practice of care. The study finding also showed that specialists/consultants were less supportive of a guideline being incorporated into practice. One clinician in this group specifically stated that "no two patients will recover at the same rate or respond in the same way to medications". This remark is essentially mindful in that no clinical scenario could ever be precisely identical to another, and no guidelines could ever be applied to all situations. The finding is consistent with that noted in a study of guideline implementation, by which clinicians with more experience and specialty training were less likely to be influenced by guidelines [32].

The strength of our study is that survey was done with clinicians across a broad spectrum of specialties. However, there are several limitations worth noting. Despite much time and effort spent in designing and executing the survey, the response rate was considered only moderate. This could be attributed to the inopportune timing of the survey as it was carried out through Christmas and New Year seasons during which many clinicians were away for the holiday break. The researcher was well aware of the relatively large number of absentees, but had to conduct the survey due to personal reasons. Response bias is inevitable as with all physician survey research owing to self-reported beliefs and practices, not actual bahaviour. In our survey, clinicians were asked to consider mild to moderate infections. It is possible that different clinician could have different types of infection in mind upon responding to the questionnaire. The single-centre nature of the study suggested that the findings are subjected to institutional and geographical biases which could not reflect practice beliefs of real world clinicians. Due to the time constraint, implementation of the IV-to-oral antibiotic switching program could not be carried out at this point of time.

In conclusion, clinicians believed that patients with mild to moderate infections could be safely switched from IV to oral antibiotics once they are able to tolerate orally, the microbiology etiology is known, the temperature had normalised and there was no more evidence of suppurative infection. There was considerable variation in several practice beliefs among clinicians of various characticteristics. Most clinicians would continue IV therapy for patients they perceived as clinically unstable. Specialists/consultants and those with overseas practice were found to be more knowledgeable about the switching practice. Despite that, the former group was generally less supportive of a guideline being incorporated in practice. Hence, guidelines that are carefully developed are essential to address the heterogeneity in the practice beliefs we observed.

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REFERENCES

1. Mohd Hanafiah R, Gan YL, Lee CL. Antibiotic purchase at Hospital Pulau Pinang. 2009
2. Wong-Beringer A, Nguyen K, Razeghi J. Implementing a program for switching from i.v. to oral antimicrobial therapy. Am J Health Syst Pharm 2001; 58: 1146-9.
3. Wetzstein G. Intravenous to oral (IV:PO) Anti-infective Conversion Therapy2000: Available from: http://www.medscape.com/viewarticle/408980.

4. Fine M, Stone R, Lave J, Hough L, Obrosky D, Mor M, *et al*. Implementation of an evidence-based guideline to reduce duration of intravenous antibiotic therapy and length of stay for patients hospitalized with community-acquired pneumonia: A randomized controlled trial. Am J Health Syst Pharm 2003; 115: 343-51.
5. Gunten V, Amos V, Sidler A, Beney J, Troillet N, Reymond J-P. Hospital pharmacists' reinforcement of guidelines for switching from parenteral to oral antibiotics: a pilot study. Pharm World Sci. 2003; 25(2): 52-5.
6. Hunter K, Dormaier G. Pharmacist-managed intravenous to oral step-down program. Clin Ther 1995; 17: 534-40.
7. Laing R, Mackenzie A, Shaw H, Gould I, Doughlas J. The effect of intravenous-to-oral switch guidelines on the use of parenteral antimicrobials in medical wards. J Antimicrob Chemother. 1998; 42: 107-11.
8. McLaughlin C, NB, Boyter A, Fenelon C, Fox J, Seaton R. Pharmacy-implemented guidelines on switching from intravenous to oral antibiotics: An intervention study. QJM. 2005; 98: 745-52.
9. Mertz D, Koller M, Haller P, Lampert M, Plagge H, Hug B, *et al*. Outcomes of early switching from intravenous to oral antibiotics on medical wards. J Antimicrob Chemother. 2009; 64: 188-9.
10. Omidvari K, Boisblanc B, Karam G, Nelson S, Haponik E, Summer W. Early transition to oral antibiotic therapy for community-acquired pneumonia:duration of therapy, clinical outcomes, and cost analysis. Respir Med. 1998; 92: 1032-9.
11. Ramirez J, Vargas S, Ritter G, Brier M, Wright A, Smith S, *et al*. Early switch from intravenous to oral antibiotics and early hospital discharge: A prospective observational study of 200 consecutive patients with community-acquired pneumonia. Arch Intern Med. 1999; 159: 2449-54.
12. Rwalins M, Cerbe L. Intravenous to oral (IV to PO) antimicrobial switching. ASA Newsletter2006. p. 1-7.
13. Senn L, Burnand B, Francioli P, Zanetti G. Improving appropriateness of antibiotic therapy: Randomised trial of an intervention to foster reassessment of prescription after 3 days. J Antimicrob Chemother. 2004; 53: 1062-7.
14. Servinc F, Prins J, Koopmans R, Langendijk J, Bossuyt P, Danjert J, *et al*. Early switch from intravenous to oral antibiotics: guidelines in a large teaching hospital. J Antimicrob Chemother. 1999; 43: 601-6.
15. Vogtlander N, Kasteren M, Natsch S, Kullberg B, Hekster Y, Meer J. Improving the process of antibiotic therapy in daily practice: Interventions to optimise timing, dosage adjustment to renal function and switch therapy. Arch Intern Med. 2004; 164: 1206-12.
16. Halm E, Switzer G, Mittman B, Walsh M, Chang C, FIne M. What factors influence physicians' decisions to switch from intravenous to oral antbiotics for community acquired pneumonia? J Gen Intern Med. 2001; 16: 599-605.
17. Kuper K. Intravenous to oral therapy conversion Bethesda: Am J Health Syst Pharm; 2008. Available from: www.ashp.org/DocLibrary/MemberCenter/ClinicalSpecialistandScientists/IVtoPO.pdf.
18. Fine M, Smith M, Carson C, Mutha S, Sankey S, Weissfeld L, *et al*. Prognosis and outcomes of patients with community-acquired penumonia. JAMA. 1996; 275(2): 134-41.
19. Halm E, Fine M, Marrie T, Coley C, Kapoor W, Obrosky D, *et al*. Time to clinical stability in patients hospitalized with community-acquired pneumonia. JAMA. 1998; 279(18): 1452-7.
20. Halm E, Causino N, Blumenthal D. Is gatekeeping better than traditional care? JAMA. 1997; 278(20): 1677-81.
21. Cacares V, Stange K, Kikano G, Zyzanski S. The clinical utility of a day of hospital observation after switching from intravenous to oral antibiotic therapy in the treatment of pyelonephritis [Abstract]. J Fam Pract. 1994; 39: 307-16.
22. Rhew D, Hackner D, Henderson L, Ellrodt A, Weingarten S. The clinical benefit of in-hospital observation in 'low-risk' pneumonia patients after conversion from parenteral to oral antimicrobial therapy. Chest. 1998; 113: 142-6.
23. Siegel R, Halpern N, Almenoff P, Cashin R, Lee A, Greene J. A prospective randomised study of inpatient IV antibiotics for community-acquired pneumonia: The optimal duration of therapy. Chest. 1996; 110: 965-71.
24. Angel J, O'Brien W, Finan M, Morales W, Lake M, Knuppel R. Acute pyelonephritis in pregnancy: A prospective study of oral versus intravenous antibiotic therapy [Abstract]. Obstet Gynecol 1990; 76(1): 28-32.
25. Cooke J, Cairns C, Tillotson G, Conner S, Lewin S, Tredree R, *et al*. Comparative clinical, microbiologic, and economic audit of the use of oral ciprofloxacin and parenteral antimicrobials [Abstract]. Ann Pharmacother. 1993; 27: 785-9.
26. Hackam D, NC, YK, DR D, DV, JC M, *et al*. Bioavailability of oral ciprofloxacin in early postsurgical patients. Arch Surg. 1998; 133: 1221-5.
27. Hoppe J. Rational prescribing of antibacterials in hospitalised children [Abstract]. Pharmacoeconomics. 1996; 10: 575-93.
28. Drew R. Programs promoting timely sequential antimicrobial therapy: an American perspective. J Infect. 1998; 37(Supp 1): 3-9.
29. Cunha B. Intravenous to oral antibiotic switch therapy. Postgrad Med. 1997; 101: 111-23.
30. Davey P, D N. Sequential antibiotic therapy: The right patient, the right time and the right outcome. J Infect. 1998; 37(1): 37-44.
31. Halm E, Atlas S, Borowsky L, Benzer T, Singer D. Change in physician knowledge and attitudes after implementation of a pneumonia practice guideline. J Gen Intern Med. 1999; 14: 688-94.
32. Halm E, Atlas S, Borowsky L, Benzer T, Metlay J, Chang Y, et al. Understanding physician adherence with a pneumonica practice guideline. Arch Intern Med. 2000; 160: 98-104.