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Impact of Stewardship Intervention on Improving Antibiotic Prescribing Practices

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Abstract

Background: Antimicrobial stewardship programs (ASPs) have been found to be an effective method for minimizing antibiotic misuse.

Method: A study comparing the quality of antibiotic prescriptions between a one-year period before ASP implementation and a one-year period after its implementation. For each period, antimicrobial prescriptions were evaluated by an antimicrobial stewardship team and classified as appropriate or inappropriate.

Results: An improvement between Phase I and Phase II was found in all antibiotic therapies.

Discussion: The overall antibiotic inappropriate rate was 45.8% before implemented the stewardship program, which is relatively high and consistent with the findings of other studies mentioned in the literature.

Conclusion: Applying the stewardship program led to a significant decrease of the inappropriate use of antibiotics at the hospital.

Keywords: Practice; Physician; Behavior; Antibiotic use; Infection

Introduction

Antimicrobial agents have been widely used in hospital settings inspite of the frequent alarms that their use is directly proportional to the emergence of bacterial resistance. At least 70% of healthcare-associated infections are caused by multi-drug resistant organisms, according to the NIAID. Every year, nearly 2 million patients acquire a nosocomial infection, 900,000 of whom die affected by this infection [1]. Antimicrobial prescribing is especially high in Intensive Care Units (ICU); one study revealed that 68–80% of ICU patients received antimicrobial agents during their stay, and a more recent study found no improvement with over 70% of patients continuing in the same prescribing pattern [2]. Clinician prescribing practices, limited regulations of antibiotics worldwide, broad-spectrum antibiotic use, erratic infection control, live-stock and agricultural use and consumer knowledge are all contributing factors to antimicrobial resistance [3].

Appropriate prescription of antimicrobials was defined by WHO as "the cost effective use of antimicrobial which maximizes clinical therapeutic effect while minimizing both drug related toxicity and the development of antimicrobial resistance, a similar definition was provided by the 2001 inter agency taskforce on antimicrobial resistance action plan [4].

Antibiotic Stewardship Programs

Major efforts have been made by the Center for Disease Control (CDC) and Society for Healthcare Epidemiology of America (SHEA), in order to encourage the good prescribing practice of antibiotics. In 2007, the Infectious Diseases Society of America (IDSA) and SHEA published guidelines on the development of antimicrobial stewardship programs [5]. These guidelines recommended merging the effort of ASP with a good comprehensive infection control program to limit the emergence and transmission of antimicrobial-resistant bacteria [5]. The Guidelines encourage continious collaboration between the antimicrobial stewardship team, infection control team, and pharmacy and therapeutics committees. As for the elements or strategies recommended by the guidelines, they include both active and supplemental antimicrobial stewardship strategies.

Antibiotic stewardship programs have been shown to have an optimistic effects on the use of antibiotic, reducing bacterial resistance, and in turn, reducing the healthcare costs [6,7]. Antibiotic stewardship should aid physicians in choosing the appropriate necessary antimicrobial agent to improve outcomes.

To measure the degree of success of antimicrobial stewardship efforts, the guidelines recommend monitoring process and outcome variables, where the process variables would include the degree to which antimicrobial use changed, and the outcome variables would include reduction in resistance, decreased infection rates, and lowered costs as a result of the process change.

Methods

The study took place in a Lebanese private teaching hospital located in the south of Lebanon with a capacity of 140 beds. This hospital provides the highest standards of quality care to patients across Lebanon and the surrounding countries in some incidences. It is home to numerous centres of excellence and specialized clinical services that provide patients with the highest standards of evidence-based treatments using a multidisciplinary approach to care. It has variety of services, which include: cardiothoracic surgery, paediatric, surgical units, internal medicine units, obstetrics, oncology, neonatal intensive care unit, medical intensive care unit, cardiac intensive care unit, post-open heart surgery intensive care unit, paediatric intensive care unit, cardiac ward, haemodialysis unit, rehabilitation centre.

The first phase (Phase 1) consisted of a retrospective audit study was performed at a hospital from 1st June 2012 until the 30th April 2013 (twelve months period). During this year, all patients admitted to the hospital were considered as our population. 10151 patients were admitted to the hospital during this year where 6068 of them received one or more dose of antibiotic during their stay. Our sample size was calculated using the following formula (Appendix A) published by the research division of the National Education Association [8].

The sample was selected using systematic random sampling. A list of patients' medical record numbers (MRN) for the whole population (6068 patients) was printed and then the first number from the population was selected. Then, each 16th subject from the same list (6068/368=16) was selected for review using an EXCEL sheet 2007.

Data Collection

All the necessary and required medical information related to the patients from the electronic medical records and patients' files were retrospectively retrieved. Each patient file was reviewed and abstracted using an excel sheet 2007 based on each patient case number (MRN) and not based on their names.

Data elements included demographic and clinical variables, as well as process-of-care measures. Collected data included: age, sex, admission site, history of infection, co-morbid illnesses, admission date, duration of hospitalization, ward, surgical procedures, ICU stay during hospitalization, current immunosuppression, ID specialist consultation during hospitalization, antibiotics used (choice, dose, duration, route and whether the drugs were given in prophylactic or therapeutic purpose).

Prescriptions were classified as 'empirical' when the pathogen was unknown at the time of prescription, and as 'targeted' when a pathogen was identified. "Prophylactic" antibiotics were related to patients undergoing surgeries only (IDSA). Furthermore, the results of microbiological, radiological and pathological investigations available at the time of the survey were reviewed to assess the appropriateness of diagnoses of infectious diseases leading to the prescriptions of antimicrobials.

Assessment of Appropriateness of Antibiotic Use

An antimicrobial stewardship team was formed in the hospital and consisted of the researcher as a chairman, infectious diseases specialist, clinical pharmacist and a floor medical resident. This team reviewed all the collected patient medical information to determine whether antimicrobial therapy was empiric, prophylactic, or targeted and to judge on the appropriateness of the prescribed antimicrobials for these patients.

The appropriateness of antimicrobial prescriptions was evaluated according to international evidence-based guidelines, and considering local epidemiology of antimicrobial resistance, microbiological findings (if available), and co-morbidity. The researcher classified the appropriateness of antimicrobial treatment using a standardized algorithm reported by "Société Suisse d'Hygiène Hospitalière Gyssens". This algorithm was chosen as a validated method that allows for a systematic evaluation of all aspects of antimicrobial prescription. In brief, AMT was judged as follows: appropriate antibiotic indication, choice, dose, route, interval, duration and de-escalation. This score system only took into account patients who were on antibiotic therapy.

After the completion of Phase I (retrospective data collection and analysis), the researcher held a seminar to show physicians that there is an antibiotic overuse in the hospital with an aim to convince them about the importance of changing the antibiotic prescription practices. The physicians were not aware that they were taking part in a research study, but rather in a project to improve judicious use of antibiotics. Physicians who attended the seminar signed "participation forms", kept in the medical administration department.

The next phase (Phase 2) started on the 1st of April 2014 and ended March 2015. The researcher started an inexpensive antimicrobial stewardship intervention where he asked physicians to document their rationale behind using antibiotics by filling an antibiotic assessment (AA) form (APPENDIX B). There were two main objectives behind the intervention done in this phase: to detect the factors that the hospital clinicians considered when deciding to start an antibiotic agent and to test the effect of this intervention on improving antimicrobial stewardship at the hospital.

The antimicrobial order form adapted was by developed by Durbin, Lapidas and Goldmann (1981). The study's AA form asked the physicians for: (1) antimicrobials prescribed, (2) possible diagnoses requiring antimicrobial therapy, (3) vital signs (temperature, heart rate, blood pressure, and respiratory rate), (4) laboratory test results (e.g., C-reactive protein [CRP], white blood cell count [WBC], etc.), and findings on physical examination.. This intervention was made systemic in a way that antibiotics could not be dispensed by the pharmacy before filling this AA form.

Physicians were required to categorize antimicrobial use as prophylactic, empiric, or therapeutic. To assess the efficacy of this intervention, the researcher evaluated antimicrobial use in the unit during the two periods (Phase I and Phase 2).

Results

Phase I and Phase II: The Effect of the Intervention

Compares the findings from Phase I and Phase II, antibiotic class appropriateness. An improvement between Phase I and Phase II was found in all antibiotic therapies (Table 1).

	Phase I		Phase II		
	Total	%	Total	%	
Aminoglycoside	77	74%	65	86%	
Penicillin	115	50%	97	69%	
Macrolide	62	85%	65	95%	
Cephalosporin	281	67%	268	83%	
Quinolone	81	70%	61	83%	
Tetracycline*	3	33%	0	0%	
Polymyxin	13	100%	12	100%	
Carbapenem	52	81%	49	87%	

Metronidazole	16	50%	7	71%	
Rifamycin	9	78%	9	100%	
Glycopeptides	86	94%	60	100%	
P-value					P<0.001
*Couldn't be calculated					

Table 1: Comparison between Phase I & Phase II: Antibiotic Class Appropriateness.

The most frequently prescribed antibiotics were cephalosporin and penicillin; however, the most frequently antibiotic usage was empiric antimicrobial therapy. When judged independently, 27.3% of the individual antibiotics were inappropriately used.

Among the patients treated by antibiotics for prophylactic indication in the retrospective study, 65.8% of those treated with the correct indication were appropriate ($p<0.05$). 78.9% of those treated with the correct choice and duration were appropriate ($p<0.05$), 79.2% of those treated with the correct dose were appropriate ($p<0.05$), 79.6% of those treated with the correct frequency were appropriate ($p<0.05$), and 96.9% of patients treated with the correct route were appropriate ($p<0.05$).

Compared to patients treated by prophylactic indication in the prospective study, 77.23% of those treated with the correct indication were appropriate ($p<0.05$), 88.27% of those treated with the correct choice, dose and route were appropriate ($p<0.05$), 89.2% of those treated with the correct frequency were appropriate ($p<0.05$), and 98.9% of patients treated with the correct duration were appropriate ($p<0.05$).

Among the patients treated by antibiotics for empiric indication in the retrospective study, 77.3% of those treated with the correct indication were appropriate ($p<0.05$), 94.2% of those treated with the correct choice, frequency, duration, and route were appropriate ($p<0.05$), and 99.6% of patients treated with the correct dose were appropriate ($p<0.05$). Compared to patients treated by antibiotics for empiric indication in the prospective study, 90.1% of those treated with the correct indication were appropriate ($p<0.05$), 95.6% of those treated with the correct choice, duration, and route were appropriate ($p<0.05$), and 97.9% of patients treated with the correct frequency were appropriate ($p<0.05$).

Out of the prescribed antibiotics during this phase, prophylactic antibiotics were the highest among empiric and targeted therapy. Prophylactic antibiotics were mostly inappropriately used when physicians prescribed antibiotics when not necessarily indicated or needed (exceed the recommended treatment duration). In fact, inappropriate indication constituted the major cause of inappropriateness among the three antibiotic categories (prophylactic, empiric and targeted). With respect to the prescribed antibiotic 50.4% of penicillin and 33.1% of cephalosporin were inappropriately prescribed.

Compares the rate of patients appropriately treated by antibiotics based on indication, choice, dose, frequency, duration and route from Phase I and Phase II. An improvement between Phase I and Phase II was found in criterion except for route, which decreased (Table 2).

Prescribing of antibiotics did not vary dramatically across patient characteristics for both males and females, and different age groups. However, there was a significant correlation between the type of attending physician and antibiotic appropriateness, where pulmonologists yielded the highest prescribers with a relatively high inappropriateness. During Phase I, 25% of the randomly selected patients were taking more than two antibiotics during their stay in the hospital with a 59.1% inappropriate prescription rate.

	Phase I		Phase II		
	Total	%	Total	%	
Indication	744	76%	674	87%	
Choice	632	90%	621	94%	
Dose	610	92%	609	96%	
Frequency	628	90%	618	95%	
Route	587	96%	621	94%	
P-value					P<0.001

Table 2: Comparison between the two phases: appropriateness criteria.

In the second prospective phase of the study, the researcher aimed at assessing the factors that physicians considered when deciding to start an antibiotic especially those antimicrobials that are prescribed empirically. Data from the AA forms suggested that the majority of physicians relied on only one factor (39.1%) before initiating an antibiotic therapy. The most frequent factors being documented when starting an antibiotic therapy were: fever, dyspnoea, elevated CRP and the presence of a chronic illness.

Discussion

This study aimed to provide baseline epidemiological data on the use of antibiotics in a Lebanese hospital and has revealed several notable patterns of antibiotic prescribing practices among Lebanese physicians. The overall antibiotic inappropriate rate was 45.8%, which is relatively high and consistent with the findings of other studies mentioned in the literature. In this phase of the study, the researcher needed to determine the percentage of patients who received antimicrobial agents, the antimicrobial agents most frequently used, and how the physicians prescribed these agents. The findings of these descriptive data were important to judge the need for adopting an antimicrobial stewardship intervention in the hospital and to reduce the unnecessary antibiotic used. The second objective of implementing Phase II was to detect the effect of antimicrobial stewardship intervention (filling the AA form on reducing the unnecessary antibiotic use and enhancing the appropriateness of antibiotic prescription). Descriptive data from this prospective phase showed the effectiveness and success of the implemented intervention by reducing the overall inappropriate antibiotic therapy from 45.8% to 22.7%, in Phase I and Phase II respectively. Whereas the percentage of total inappropriate antibiotic prescriptions were decreased from 27.3% to 15.0% in Phase I and Phase II, respectively. Most importantly, there was an obvious significant correlation in the improvement of appropriateness between all types of antibiotics being prescribed. In addition, the total number of prescribed antibiotics with the 'duration of the treatment' significantly decreased.

Similarly, a one-month study about appropriateness in the use of antibiotics was done in Egypt between two university hospitals, A in

Shams University Hospital and MUST University Hospital and found that inappropriate antibiotics prescribing was high for reasons including wrong choice old drugs and dose errors [9]. Generally, the inappropriate use of antibiotics, i.e. the documentation, which shows that the infection is not well treated, plays a very important role in the emergence of antimicrobial resistance. Several factors contribute to the inadequate antimicrobial treatment, such as the previous exposure to antibiotics especially those with broad spectrum, long length of stay in hospitals, and unnecessary antibiotic prescriptions.

A study was done between the years 2001 and 2004 at the Ataturk University Medical School, Turkey compared the use and consumption of antibiotics before and after an antibiotic restriction policy was applied in 2003 by infectious diseases specialists and total consumption of antibiotics decreased along with antibiotic usage [10].

Trouillet et al. [11] described 135 episodes of ventilator-associated pneumonia. The study showed that in more than one half (57%) of these episodes, the main cause was antibiotic resistant bacteria. Moreover, it demonstrated that the prior use of third generation cephalosporins, fluoroquinolones, and/or imipenem, was associated with the development of ventilator-associated pneumonia due to resistant pathogens. This implies that the previous exposure to antibiotics is the leading cause of nosocomial infections due to antibiotic resistance of pathogens [12]. Many surveys demonstrated the obvious significant benefits regarding the physicians' practice of prescribing the first choice antibiotic when referring to antibiotic practice guidelines. Such guidelines could be the employment of a computerized system or the use of an automated antimicrobial prescribing system [13], which both in turn, have reduced the occurrence of the inappropriate empirical administration of antibiotics.

While much work has been done to understand physicians' prescribing behavior in general, comparatively little work has been done to identify clinical infection parameters, such as vital signs, laboratory test results, and microbiologic test results, that physicians consider when prescribing antimicrobial agents. The current study had a principal finding. Data from the AA forms suggested that physicians frequently considered combinations of elevated temperature, elevated CRP, and elevated WBC count when initiating empiric or targeted antimicrobial treatment, while perioperative coverage was the major reason that they initiated prophylactic antimicrobial treatment.

The researcher used documentation as a strategy to improve antimicrobial stewardship because several investigators previously showed that this approach together with measures, such as automatically discontinuing antimicrobials, could decrease antimicrobial use. It was obvious that this study assisted in decreasing the antibiotic use among different antibiotic categories, antibiotic duration, antibiotic consumption among different types and the median duration of empiric and targeted antimicrobial therapies. The decreases in the duration of empiric and targeted treatments and all other parameters were significant statistically.

Conclusion

In our study, we could statistically confirm that before applying the Antibiotic Assessment form as a part of the Stewardship Program, the percentage of misuse of the above antibiotics was indeed high; however, after applying the program, there was a significant decrease of the inappropriate use of antibiotics. Therefore, the study contributed in many successful points, for example, improving the physicians' behaviour and practice especially regarding appropriate prescribing, besides decreasing the nosocomial infection rates, which in turn plays a very important role in decreasing the medication costs and improving healthcare aspects.

When designing new interventions in antimicrobial prescribing, it is paramount that primary research into prescribing behavioural intention of individuals is performed and that interventions are tailored to the target audience in whom behaviour change is desired. This can lead to an understanding of the barriers to and facilitators of behaviour change; enable development of interventions that utilize facilitators and overcome barriers; and promote more sustainable and effective outcomes. To ensure effective and sustainable interventions, research in this field needs to move away from the traditional single-disciplinary approach towards a multidisciplinary team approach (Olson and Toomanalvarado) that engages with a wide range of disciplines (eg, behavioural, social, and communication sciences).

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