Effects of Pharmacist Intervention on the Utilization of Vancomycin in a Teaching Hospital

Maria Tavakoli-Ardakani\textsuperscript{a}, Samaneh Ghassemi\textsuperscript{b}, Afshin Mohammad Alizadeh\textsuperscript{c*}, Jamshid Salamzadeh\textsuperscript{a}, Mojtaba Ghadiani\textsuperscript{d} and Sara Ghassemi\textsuperscript{b}

\textsuperscript{a}Department of Clinical Pharmacy, School of Pharmacy and Pharmaceutical Sciences Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran. \textsuperscript{b}Student Research Committee, School of Pharmacy, Beheshti University of Medical Sciences, Tehran, Iran. \textsuperscript{c}Division of Infectious Diseases, Taleghani Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran. \textsuperscript{d}Department of Clinical Pharmacy, School of Pharmacy and Pharmaceutical Sciences Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

Abstract

In order to investigate the effect of pharmacist intervention on vancomycin use, this study was performed on all patients receiving vancomycin in the intensive care unit (ICU) and hematology-oncology ward of Taleghani Educational Hospital in Tehran, Iran. Vancomycin use was assessed during a pre- and post-intervention period in accordance with the Center of Disease Control and prevention (CDC) and Infectious Diseases Society of America (IDSA) guidelines. Following the intervention, there was a significant change in appropriate initiation of vancomycin ($P = 0.009$) and no significant improvement was observed in adequate dosage and the duration of therapy ($P = 0.15$ and $P = 0.54$ respectively); however, informing the physician resulted in discontinuation of the drug in 50% of inappropriate cases and vancomycin dosage was adjusted in 31% of cases. Temperature charts, culture results and pre-treatment CBC tests changed significantly ($P = 0.02$, $P = 0.009$ and $P = 0.04$ respectively). The rate of infusion related adverse drug reactions did not decrease significantly ($P = 0.06$); yet in 100% of patients, these reactions were resolved after notifying the nursing team. After pharmacist intervention, vancomycin use improved in some aspects. A significant improvement in appropriate initiation of therapy was observed; however, treatments continued despite negative cultures. It is necessary to optimize the use of vancomycin by performing more educational interventions.

Keywords: Pharmacist intervention; Vancomycin; Drug use evaluation; Guidelines; Antibiotic use.

Introduction

Over the past two decades, development of multiple resistances to antibiotics among gram positive organisms has raised concern (1, 2). Strains of \textit{Staphylococcus aureus} resistant to methicillin (MRSA) are considered one of the main causes of hospital acquired infections and acquired resistance to conventional antibiotics makes their treatment difficult (3). Infections caused by MRSA and \textit{Staphylococcus} coagulase-negative have increased and left vancomycin as the antibiotic of choice in the treatment of these infections (4, 5, 6).
1282

Methods

The present study was approved by Ethical Committee of the Shahid Beheshti University of Medical Sciences and conducted at the intensive care unit and hematology-oncology ward of Taleghani Teaching Hospital in Tehran, Iran, between January 21, 2011 and January 21, 2012. All the patients prescribed intravenous vancomycin were enrolled in the study. We evaluated vancomycin use at two intervals: at baseline and during pharmacist intervention.

The medical charts and laboratory data of patients receiving vancomycin were reviewed by a pharmacist. Also further data was collected from the patients and from the medical staff. Extracted data included demographics, indication, dosing regimen, rate and duration of administration, culture and sensitivity results, medication history, adverse drug reactions, white blood cells (WBC) counts, serum creatinine, urine analysis and blood urea nitrogen. To indicate the appropriateness, vancomycin use was assessed according to the criteria published by Hospital Infection Control Practices Advisory Committee guidelines in the hematology-oncology ward and the intensive care unit in a tertiary teaching hospital in Iran (1, 23).

| Table 1. Published criteria by the CDC for vancomycin use (1). |
|---------------------------------------------------------------|
| **Vancomycin Use**                                           |
| **Appropriate**                                               |
| Serious infections caused by beta-lactam resistant gram-positive microorganisms |
| Infections caused by gram-positive microorganism in patients allergic to beta-lactam antimicrobials |
| Antibiotic-associated colitis that fails to respond to metronidazole therapy or is severe and potentially life-threatening |
| Prophylaxis, as recommended by the American Heart Association, for endocarditis following certain procedures in high risk patients |
| Surgical prophylaxis, with prosthesis implant, in institutions with high rates of infections caused by MRSA or methicillin-resistant Staphylococcus epidermidis |
| **Inappropriate**                                             |
| Routine surgical prophylaxis other than in patients with a life threatening allergy to beta-lactam antibiotics |
| Empiric antimicrobial therapy for a febrile neutropenic patient, unless strong evidence is present of an infection caused by gram-positive microorganisms and the prevalence of infections caused by MRSA in the hospital is substantial |
| Treatment of a single blood culture for coagulase-negative Staphylococcus if other blood cultures collected simultaneously are negative |
| Continued empiric use in patients whose cultures are negative for beta-lactam-resistant gram-positive microorganisms |
| Systemic or local prophylaxis for infection or colonization of indwelling central or peripheral intravascular catheters |
| Selective decontamination of the gastrointestinal tract |
| Eradication of MRSA colonization |
| Primary treatment of antibiotic-associated colitis |
| Routine prophylaxis for very low-birthweight infants |
| Topical application or irrigation of vancomycin solution |
| Treatment (chosen for dosing convenience) of infections caused by beta-lactam-sensitive gram-positive microorganisms in patients with renal failure |
| Routine prophylaxis for patients on continuous ambulatory peritoneal dialysis or hemodialysis |

MRSA: methicillin resistant Staphylococcus aureus
An assessment of vancomycin use of the CDC and guidelines published by IDSA.

The major aspects of vancomycin misuse were clarified following the primary evaluation of vancomycin administration. The intervention began on July 23, 2011, and evaluated the same parameters. The two phases of our study were performed under the same circumstances. We monitored accurately each patient for whom vancomycin was prescribed. Based on the guidelines and consultations with the infection diseases specialist, we determined the accuracy of each treatment. Whenever vancomycin use was not in accordance with the guidelines, pharmacist contacted the physicians, informing them about inappropriate vancomycin use. If the previous strategy still continued despite the intervention, a discussion with physician was considered.

Data analysis was done by chi-square ($\chi^2$) or Fisher’s exact tests and significance was defined as a p-value lower than 0.05.

**Results and Discussion**

**Pre-intervention data**
During the first monitoring period, a total of 77 patients were evaluated. The most common reason for vancomycin use was fever and neutropenia (16.35%) (Table 2). Initiation of therapy was compatible with the guidelines in 38.96% of patients and duration of therapy was considered appropriate in 83.33% of patients for whom vancomycin was initiated correctly. Only 54.55% of cases received an appropriate dosing regimen based on age, weight and creatinine clearance calculated by the Cockcroft-Gault equation.

Overall, 55 of 77 patients (71.43%) had microbial culture order before the first dose of vancomycin and the culture results were available only in 28 patients (50.91%). Infusion related adverse drug reactions were detected in 17 patients (22.08%), while the other 60 patients (77.92%) did not show any adverse reactions to vancomycin infusion.

**Post intervention data**
A total of 82 patients were evaluated during a 6 month intervention period. Fever and neutropenia were the most common cause of vancomycin use (15.09%). Compliance with guidelines improved from 38.96% in the pre-intervention period to 59.76% in the post-intervention period.
intervention period ($P = 0.009$). No significant improvement was observed for appropriate duration and dosing regimen of vancomycin use ($P = 0.54$ and $P = 0.15$). Only 49 out of 82 patients initiated the treatment correctly. Eleven patients were receiving inappropriate dosage of vancomycin and against the medical advice, one of them had a prior discharge from the hospital, refusing further treatments by signing a consent. Discussion with the physician resulted in the discontinuation of the drug in 50% of the remaining cases (five out of ten) and vancomycin dosage was adjusted in 30.77% of the patients after the second intervention (Table 3).

The duration of vancomycin therapy was evaluated in patients to whom vancomycin was prescribed and initiated correctly (30 patients before the intervention, and 49 patients after the intervention). The duration of treatment was appropriate in 25 and 38 patients respectively.

From necessary pre-treatment laboratory tests, only complete blood count (CBC) test orders raised significantly ($P = 0.04$) (Table 4). Available temperature charts also showed a significant improvement with a p-value of 0.02 (Table 5). Culture orders before initiation of vancomycin therapy did not improve statistically ($P = 0.55$). However, during the intervention period, culture results were significantly raised from 50.91% to 74.19% ($P = 0.009$) (Table 6).

Infusion related adverse drug reactions occurred in 9 patients (10.98%) which compared with 22.08% at the baseline did not change significantly ($P = 0.06$), despite that in 100% of cases these reactions were resolved after notifying the nursing team during the second intervention.

Overuse of antibiotics is considered a challenging issue in community and hospital settings (24, 25, 26). Inappropriate use of antibiotics can result in emergence of bacterial resistance (27), which could further affect the patient’s outcomes (28). Thus several studies have been conducted to control and restrict the use of these drugs (27, 29-31). The aim of our study was to control and improve vancomycin use by pharmacist intervention based on HICPAC and IDSA guidelines.

At the baseline 61.04% of vancomycin indications and 16.67% of prescription durations were considered appropriate. Following the interventions performed by a pharmacist inappropriate initiation of vancomycin decreased to 40.24%, but no significant change was observed in inappropriate duration of vancomycin therapy.

In a prospective two-phase study performed by Misan et al. (32), the role of educational

### Table 3. Appropriateness of initiation, duration and dosing regimen of vancomycin therapy.

| Evaluated parameter                                                                 | N (and %)          | p-value |
|------------------------------------------------------------------------------------|--------------------|---------|
| Initiation of vancomycin therapy                                                   |                    |         |
| Appropriate initiation before the intervention                                     | 30(38.96)          | 0.009   |
| Appropriate initiation after the intervention                                      | 49(59.76)          |         |
| Vancomycin therapy stopped following discussions with the physicians              | 18(54.55)          | N/A     |
| Duration of vancomycin therapy                                                    |                    |         |
| Appropriate duration before the intervention                                       | 25(83.33)$^a$      | 0.54    |
| Appropriate duration after the intervention                                        | 38(77.55)$^a$      |         |
| Vancomycin therapy stopped following discussions with the physicians              | 5(50)              | N/A     |
| Dosing regimen of vancomycin therapy                                               |                    |         |
| Appropriate dosing regimen before the intervention                                  | 42(54.55)          |         |
| Appropriate dosing regimen after the intervention                                   | 54(65.85)          | 0.5     |
| Dosing regimen adjusted following discussions with the physicians                  | 8(30.77)           | N/A     |

NA: Not Applicable

### Table 4. Assessment of pre-treatment laboratory tests.

| Laboratory test | Before intervention: n (and %) | After intervention: n (and %) | p-value |
|-----------------|--------------------------------|------------------------------|---------|
| CBC test        | 69(89.61)                      | 80(97.56)                    | 0.04    |
| Renal function  | 64(83.12)                      | 73(89.02)                    | 0.28    |
| UA              | 23(23.87)                      | 34(41.46)                    | 0.13    |

CBC: complete blood count, UA: urinalysis
interventions on vancomycin use was assessed in a large metropolitan teaching hospital. Interventions seemed to have no effects on reducing inappropriate vancomycin prescribing. The study demonstrated that directly consulting with prescribers was the most effective strategy.

In another veterans affairs-affiliated medical center, vancomycin orders were evaluated by Lipsky et al. (33), first at baseline and following administrative and educational interventions. Administrative interventions included discussion sessions held by a clinical pharmacist or the chair of the infection control committee who revised routine perioperative prophylaxis orders. Educational interventions consisted of discussions with physicians regarding VRE and appropriate prescribing of vancomycin. Despite a transient decrease after educational interventions, inappropriate use of vancomycin declined from 70% of orders at baseline to 40% after administrative interventions. In accordance with our study, the goal was to assess and promote vancomycin use. However the way that interventions were performed was different. In our study the use of vancomycin was assessed under the supervision of a clinical pharmacist, while Lipsky et al., evaluated its use after direct interventions performed by a clinical pharmacist and the chair of the infection control committee.

In the assessment of vancomycin use conducted by Hamilton et al. (34), the effectiveness of pharmacist interventions was confirmed. In this study, the use of vancomycin was evaluated based on guidelines published by CDC through a survey tool. Data collection and primary interventions (such as contacting the physicians in case of non-guideline-adherent treatments) were performed by pharmacists. If inappropriate vancomycin use still continued, a consultation was offered by one of the infectious diseases consultants. Contrary to our study, a hospital-wide education was also provided by the Infection Control Department. At the end, accordance with guidelines for empiric use of vancomycin improved in all categories from 47% in the pre-intervention period to 73% after the intervention ($P = 0.16$).

Similarly, a survey performed by Guglielmo et al. used a series of interventions which consisted of automatic 72 h stop orders to improve vancomycin prescribing (35). First, vancomycin orders were reviewed based on HICPAC recommendations, then, series of interventions including an antibiotic 72 h stop order were undertaken. The study demonstrated that inappropriate vancomycin use decreased significantly in the febrile neutropenia patients ($P = 0.013$) and in the patients continuing empirical vancomycin in the absence of gram-positive infection ($P = 0.002$). Conversely, Bolon et al. reported that an antibiotic order form intervention did not improve or reduce vancomycin use (36).

Opposite to other studies in which surgical prophylaxis was the most common form of inappropriate use, no case of surgical prophylaxis was observed in our study and empirical therapy remained the major cause of inappropriate vancomycin use (37, 38). The evaluation of vancomycin use in only two specific wards

---

**Table 5.** Evaluation of patients after the initiation of vancomycin therapy.

| Description                        | Before intervention: n (and %) | After intervention: n (and %) | p-value |
|------------------------------------|-------------------------------|-------------------------------|---------|
| Temperature charts                 | 72(93.51)                     | 82(100)                       | 0.02    |
| Hearing Tests                      | 0(0.00)                       | 3(8.82)                       | 0.54    |
| Periodic WBC count monitoring      | 73(94.80)                     | 82(100)                       | 0.053   |
| Periodic monitoring of renal function | 66(85.71)                   | 75(91.46)                     | 0.25    |

WBC: white blood cell

---

**Table 6.** Analysis of cultures obtained from 159 patients receiving vancomycin at Taleghani Teaching Hospital.

| Description                          | Before intervention: n (and %) | After intervention: n (and %) | p-value |
|--------------------------------------|-------------------------------|-------------------------------|---------|
| Culture orders before initiation of therapy | 55(71.43)                     | 62(75.61)                     | 0.55    |
| Appropriate time of performing culture tests | 37(67.27)                     | 43(69.35)                     | 0.81    |
| Available results of culture tests in patient notes | 28(50.91)                     | 46(74.19)                     | 0.009   |

1285
(hematology-oncology and ICU) could possibly explain the lack of surgical prophylactic use in the present study.

Although there was a significant improvement in appropriate initiation of vancomycin, the duration of empirical therapy did not change after intervention of the pharmacist. In a large number of cases empiric treatment continued despite negative culture results. This might demonstrate the physician’s lack of confidence in the laboratory results and thus relies mainly on clinical findings rather than laboratory data. No significant increase of culture orders before initiation of therapy could also confirm this issue, whereby vancomycin was mostly prescribed in the absence of culture orders without taking into consideration the pharmacist’s reminds. Since blood culture information determines the need for vancomycin therapy or proposes another antimicrobial treatment based on susceptibility data, hospital staff must be more educated about the importance and necessity of performing culture tests.

CBC tests, as well as temperature, are considered two main factors determining the length of vancomycin therapy in febrile neutropenic patients. Among patients receiving vancomycin, in our study, a larger number were hospitalized with fever and neutropenia. After the interventions, the physicians wanted to monitor these two factors more closely than before. Pre-treatment CBC tests and temperature charts improved significantly, while periodical monitoring of WBC counts increased from 94.8% to 100%, which was not significant.

In our study like other studies (39, 40), renal function was monitored and the vancomycin dosage was corrected according to the renal function. However, the results of the intervention demonstrated no significant improvement in appropriate dosing regimen. Despite the interventions, in many cases physicians tended to follow routine and prescribe vancomycin as a fixed dose of 1 gram per patient, regardless of the weight. Unlike other studies (41, 42), no therapeutic vancomycin level monitoring was performed in the current study and adjustments of dosage was done only with respect to the renal function.

Based on our study, we suggest additional strategies to improve vancomycin use at Taleghani Teaching Hospital which include:

1. Inform clinicians about appropriate vancomycin use via brochures, handouts, mails and posters.
2. Implementing restrictive measures to control vancomycin use.
3. Direct intervention of clinical pharmacists and infectious diseases consultants to improve awareness of vancomycin usage in order to prevent and control vancomycin resistance.
4. Continue the vancomycin use evaluation to ensure the efficacy of the interventions and also compare the effects of each intervention with the other.

As the first vancomycin use evaluation at Taleghani Teaching Hospital, our study has identified the main factors associated with the inappropriate use of vancomycin in two specific wards with more vancomycin administration. However, the collaboration of physicians, infectious diseases consultants, nurses and direct supervision of clinical pharmacists is required to make the whole intervention more effective.

References

(1) Centers for Disease Control and Prevention. Recommendations for preventing the spread of vancomycin resistance. Recommendations of the Hospital Infection Control Practices Advisory Committee (HICPAC). MMWR Morb Mortal Wkly Rep (1995) 44: 1-13.
(2) Cormican MG and Jones RN. Emerging resistance to antimicrobial agents in gram-positive bacteria. Drugs (1996) 51: 6-12.
(3) Enright MC, Robinson DA, Randle G, Feil EJ, Grundmann H and Spratt BG. The evolutionary history of methicillin-resistant Staphylococcus aureus (MRSA). Proc. Natl. Acad. Sci.USA (2002) 99: 7687-7692.
(4) Ena J, Dick RW, Jones RN and Wenzel RP. The epidemiology of intravenous vancomycin usage in a university hospital. A 10-year study. JAMA (1993) 269: 598-602.
(5) Marchese A, Schito GC and Debbia EA. Emergence of drug-resistant gram-positive pathogenic bacteria. J. Chemother. (2000) 12: 12-4.
(6) Elyasi S, Khalili H, Dashiti-Khavidaki S, Emadi-Koochak H, Mohammadpour A and Abdollahi A. Elevated vancomycin trough concentration: Increased efficacy and/or toxicity? Iran. J. Pharm. Res. (2014) 13: 1241-1247.
(7) Archibald L, Phillips L, Monnet D, McGowan Jr JE,
Tenover FC and Gaynes R. Antimicrobial resistance in isolates from inpatients and outpatients in the United States: increasing importance of the intensive care unit. *Clin. Infect. Dis.* (1997) 24: 211-215.

(8) Fridkin SK, Edwards JR, Courval JM, Hill H, Tenover FC, Lawton R, Gaynes RP and McGowan JE Jr. The effect of vancomycin and third-generation cephalosporins on prevalence of vancomycin-resistant enterococci in 126 U.S. adult intensive care units. *Ann. Intern. Med.* (2001) 135: 175-183.

(9) Gin AS and Zhanel GG. Vancomycin-resistant enterococci. *Ann. Pharmacother.* (1996) 30: 615-24.

(10) Leclercq R and Courvalin P. Resistance to glycopeptides in enterococci. *Clin. Infect. Dis.* (1997) 24: 545-56.

(11) Muto CA, Jernigan JA, Ostrowsky BE, Richet HM, Jarvis WR, Boyce JM and Farr BM. SHEA guideline for preventing nosocomial transmission of multidrug-resistant strains of *Staphylococcus aureus* and enterococcus. *Infect. Control Hosp. Epidemiol.* (2003) 24: 362-386.

(12) Boyce JM, Opal SM, Chow JW, Zervos MJ, Potter-Bynoe G, Sherman CB, Romulo RL, Fortna S and Medeiros AA. Outbreak of multidrug-resistant *Enterococcus faecium* with transferable vanB class vancomycin resistance. *J. Clin. Microbiol.* (1994) 32: 1148-1153.

(13) Morris JGJ, Shay DK, Hebdon JN, McCarter RJ Jr, Perdue BE, Jarvis W, Johnson JA, Dowling TC, Polish LB and Schwabre RS. Enterococci resistant to multiple antimicrobial agents, including vancomycin. Establishment of endemicity in a university medical center. *Ann. Intern. Med.* (1995) 123: 250-259.

(14) Shay DK, Maloney SA, Montecalvo M, Banerjee S, Wormser GP, Arduino MJ, Bland LA and Jarvis WR. Epidemiology and mortality risk of vancomycin-resistant enterococcal bloodstream infections. *J. Infect. Dis.* (1995) 172: 993-1000.

(15) Rubin LG, Tucci V, Cerencado E, Eliopoulos G and Isenberg HD. Vancomycin-resistant *Enterococcus faecium* in hospitalized children. *Infect. Control Hosp. Epidemiol.* (1992) 13: 700-705.

(16) Karanjil LV, Murphy M, Josephson A, Gaynes R, Mandel L, Hill BC and Swenson JM. A cluster of vancomycin-resistant *Enterococcus faecium* in an intensive care unit. *Infect. Control Hosp. Epidemiol.* (1992) 13: 195-200.

(17) Handwerger S, Raucher B, Alatarac D, Monka J, Marchione S, Singh KV, Murray BE, Wolff J and Walters B. Nosocomial outbreak due to *Enterococcus faecium* highly resistant to vancomycin, penicillin, and gentamicin. *Clin. Infect. Dis.* (1993) 16: 750-755.

(18) Frieden TR, Munsiff SS, Low DE, Willey BM, Williams G, Faur Y, Eisner W, Warren S and Kreiswirth B. Emergence of vancomycin-resistant enterococci in New York City. *Lancet* (1993) 342: 76-79.

(19) Boyle JF, Soumakis SA, Rendo A, Herrington JA, Gianarkis DG, Thurberg BE and Painter BG. Epidemiologic analysis and genotypic characterization of a nosocomial outbreak of vancomycin-resistant enterococci. *J. Clin. Microbiol.* (1993) 31: 1280-1285.

(20) Montecalvo MA, Horowitz H, Gedris C, Carbonaro C, Tenover FC, Issah A, Cook P and Wormser GP. Outbreak of vancomycin-, ampicillin-, and aminoglycoside-resistant *Enterococcus faecium* bacteremia in an adult oncology unit. *Antimicrob. Agents Chemother.* (1994) 38: 1363-1367.

(21) Center for Disease Control and Prevention. Nosocomial enterococci resistant to vancomycin-United States, 1989-1993. MMWR Morb Mortal Wkly Rep (1993) 42: 597-599.

(22) Roghmann MC, Perdue BE and Polish L. Vancomycin use in a hospital with vancomycin restriction. *Infect. Control Hosp. Epidemiol.* (1999) 20: 60-63.

(23) IDSA Practice Guidelines. *Infectious Diseases Society of America website* (2010). Available from: URL:http://www.idsociety.org/IDSA_Practice_Guidelines.

(24) Guillomet D, Maison P, Carbon C, Balkau B, Vauzelle-Kervroëdan F, Sermet C, Bouvenot G and Eschwege E. Trends in antimicrobial use in the community-France. *J. Infect. Dis.* (1998) 177: 492-497.

(25) Bantar C, Sartori B, Vesco E, Heft C, Saili M, Salamone F and Oliva ME. A hospitalwide intervention program to optimize the quality of antibiotic use: impact on prescribing practice, antibiotic consumption, cost saving, and bacterial resistance. *Clin. Infect. Dis.* (2003) 37: 180-186.

(26) Sistanizad M, Kouche M, Mirdi M, Goharani R, Soltucki M, Ayazkhooh L, Foroumand M and Mohtari M. Carbapenem restriction and its effect on bacterial resistance in an intensive care unit of a teaching hospital. *Iran. J. Pharm. Res.* (2013) 12: 503-509.

(27) Shlaes DM, Gerding DN, John JF Jr, Craig WA, Bornstein DL, Duncan RA, Eckman MR, Farrer WE, Greene WH, Lorian V, Levy S, McGowan JE Jr, Paul SM, Ruskin J, Tenover FC and Watanakunakorn C. Society for healthcare epidemiology of America and infectious diseases society of America joint committee on the prevention of antimicrobial resistance: guidelines for the prevention of antimicrobial resistance in hospitals. *Clin. Infect. Dis.* (1997) 25: 584-599.

(28) Gross R, Morgan AS, Kinky DE, Weiner M, Gibson GA and Fishman NO. Impact of a hospital-based antimicrobial management program on clinical and economic outcomes. *Clin. Infect. Dis.* (2001) 33: 289-295.

(29) Gould IM and Jappy B. Trends in hospital antibiotic prescribing after introduction of an antibiotic policy. *J. Antimicrob. Chemother.* (1996) 38: 895-904.

(30) John JF and Fishman NO. Programmatic role of the infectious diseases physician in controlling antimicrobial costs in the hospital. *Clin. Infect. Dis.* (1997) 24: 471-485.

(31) McGowan JE Jr. Do intensive hospital antibiotic control programs prevent the spread of antibiotic resistance? *Infect. Control Hosp. Epidemiol.* (1994)
15: 478-483.
(32) Misan GM, Martin ED, Smith ER, Somogyi AA, Bartholomeusz RC and Bochner F. Drug utilization review in a teaching hospital: experience with vancomycin. Eur. J. Clin. Pharmacol. (1990) 39: 457-461.
(33) Lipsky BA, Baker CA, McDonald LL and Suzuki NT. Improving the appropriateness of vancomycin use by sequential interventions. Am. J. Infect. Control (1999) 27: 84-90.
(34) Hamilton CD, Drew R, Janning SW, Latour JK and Hayward S. Excessive use of vancomycin: a successful intervention strategy at an academic medical center. Infect. Control Hosp. Epidemiol. (2000) 21: 42-45.
(35) Guglielmo BJ, Dudas V, Maewal I, Young R, Hhits A, Willmann M, Gibbs L, Gropper M and Jacobs R. Impact of series of interventions in vancomycin prescribing on use and prevalence of vancomycin-resistant enterococci. Jt. Comm. J. Qual. Patient Saf. (2005) 31: 469-475.
(36) Bolon MK, Arnold AD, Feldman HA, Goldmann DA and Wright SB. An antibiotic order form intervention does not improve or reduce vancomycin use. Pediatr. Infect. Dis. J. (2005) 24: 1053-1058.
(37) Watanakunakorn C. Prescribing pattern of vancomycin in a community teaching hospital with low prevalence of vancomycin-resistant enterococci. Infect. Control Hosp. Epidemiol. (1997) 18: 767-769.
(38) Anglim AM, Klym B, Byers BE, Scheld WM and Farr BM. Effect of a vancomycin restriction policy on ordering practices during an outbreak of vancomycin resistant Enterococcus faecium. Arch. Intern. Med. (1997) 157: 1132-1136.
(39) Melo DO, Sasaki M and Grinbaum RS. Vancomycin use in a hospital with high prevalence of methicillin-resistant Staphylococcus aureus: comparison with Hospital Infection Control Practices Advisory Committee Guidelines (HICPAC). Braz. J. Infect. Dis. (2007) 11: 53-56.
(40) Melo DO and Ribeiro E. Vancomycin use in a Brazilian teaching hospital: comparison with the Hospital Infection Control Practices Advisory Committee Guidelines (HICPAC). Braz. J. Infect. Dis. (2009) 13: 161-164.
(41) Hing WC, Bek SJ, Lin RT and Li SC. A retrospective drug utilization evaluation of vancomycin usage in paediatric patients. J. Clin. Pharm. Ther. (2004) 29: 359-365.
(42) Dib JG, Al-Tawfiq JA, Al Abdulmohsin S, Mohammed K and Jenden PD. Improvement in vancomycin utilization in adults in a Saudi Arabian medical center using the Hospital Infection Control Practices Advisory Committee guidelines and simple educational activity. J. Infect. Public Health (2009) 2: 141-146.

This article is available online at http://www.ijpr.ir