Audit of Antibiotic Use in a Brazilian University Hospital

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A cohort study was carried out at the Marilia Medical School Hospital. In the first phase the pattern of antibiotic use was evaluated. Antibiotics were prescribed for 55.4% of the patients; antibiotic combinations were used in 43%. Therapeutic use of antibiotics was considered inadequate in 27%. Respiratory and skin infections were the most frequently diagnosed. In up to 31% of the cases the treatment of respiratory infections was considered inadequate. The surgical use of antibiotic prophylaxis was evaluated in the second phase. Prophylaxis was indicated in 73.2% of the surgeries. The antibiotics most used for prophylaxis were first generation cephalosporins. In 78.9% of the surgeries, the antibiotic was correctly chosen. In 15.9% of the surgeries, the initial antibiotic administration was correctly timed. The use of antibiotics in the post-operative period was appropriate in 29.8% of the cases. The independent risk factors for surgical site infection (SSI), as determined by logistic regression analysis adjusted to class of wound risk, were the choice of antibiotic to be used prophylactically and the duration of antibiotic treatment in the post-operative period. Those who received appropriate prophylactic antibiotics had a lower rate of SSI than those who received innapropriated antibiotics [RR=0.49/95%; CI=0.25-0.90]. Patients who received prophylactic antibiotics correctly in the post-operative period had a lower risk of SSI than those who did not [RR=0.21/95%; CI=0.70-0.63]. The mean length of hospital stay was shorter among patients whose prophylactic treatment was correctly employed than among for which it was not [6.1 (±9.8) and 11.1 (±13.5) days, p=0.25].
Key Words: Antibiotic use, evaluation, Brazil.

Antibiotic use is one of the most important factors for the development and spread of resistance in the hospital, as well as in the community. The World Health Organization has established antibiotic use as a priority in its campaign for the rational use of medications [1]. Antibiotics account for a significant proportion of total hospital drug expenditures. Furthermore, it is estimated that 50% of all physician orders for antibiotics are for the wrong drug, or an inappropriate dosage or duration. In addition, inadequate antibiotic use increases costs by increasing the length of stay in the hospital [2,3].

Received on 10 February 2004; revised 13 June 2004.
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The Brazilian Journal of Infectious Diseases 2004;8(4):272-280

Control of antibiotic use is recommended. One tool to address this problem is the elaboration of therapeutic and prophylactic protocols developed by examining each hospital's most prevalent infections, together with the local rate of bacterial resistance.

Infection at the surgical site is one of the most important types of nosocomial infection. Many studies have shown that the use of antibiotic prophylaxis in some surgical procedures can reduce these infections [4].

In spite of extensive knowledge about the effectiveness of antibiotic prophylaxis, its administration is often inappropriate. The proper use of antibiotic prophylaxis in surgical procedures requires the consideration of several factors. Effectiveness depends on the correct selection and application of the following items: appropriate antibiotic choice, timing of the initial administration, the number of dosages administered during surgery, and post-operative drug use. Incorrect execution of any of these factors can influence the rate

at which infections at the surgical site occur. Therefore it is very important to be aware of what is being done in surgical prophylaxis in order to establish improvement strategies.

Objectives

The initial aims of this study were to determine the percentage of patients who received antibiotics, the drugs most frequently used, the indications for use, and the most frequent types of infections. The objectives of the second phase of the study were to evaluate the surgical prophylaxis regimens used by surgeons at the Marilia Medical School Hospital, to compare the actual use of antibiotic prophylaxis in the surgical department with standard international guidelines, and to assess the influence of different aspects of antibiotic prophylaxis on the occurrence of infections at the surgical site.

Materials and Methods

A cohort prospective study was carried out at the Marilia Medical School Hospital, a public 100-bed university-affiliated tertiary care hospital, which has an active Hospital Infection Control Commission. In the first phase of the study, the pattern of antibiotic use in the hospital was evaluated for one month. All adult hospital in-patients were followed until their discharge from the hospital, or death. Medical records, information from the physicians involved, and daily patient records were used to obtain the data.

In the second phase of the study, the surgical use of antibiotic prophylaxis was prospectively evaluated for five months. Patients with hospital stays less than 24 hours, follow-up surgery patients and pediatric patients were not included.

Data relevant to the following questions were assessed: Did the procedure justify prophylaxis, and was it provided? Was the timing of the administration optimal (i.e., within 30 minutes up to 2 hours prior to surgery)? Was the appropriate antibiotic selected? Was the number of intra-operative doses correct? Was the duration of prophylaxis optimal? In addition, a surgical classification of clean, clean/contaminated, or contaminated was recorded. Procedures were classified as either elective or urgent. All adult surgical patients were followed until their discharge from the hospital or until they died.

Statistical analysis

A descriptive analysis was performed on the demographic and clinical data, including the infection and its classification, the most frequently used antibiotics, and the duration of antibiotic treatment. In the second phase, the patients who had correctly used antibiotic prophylaxis were compared in terms of infection at the surgical site, length of hospitalization, and outcome for those for whom antibiotic use was incorrect.

T-tests and Chi-Square tests were used to determine significance at 5%. The confidence interval of 95% was calculated. Logistic regression analysis was used to determine the variables associated with the risk of infection at the surgical site. The software Stata 6.0 was used for data analysis.

Results

Prevalence of antibiotic use

During a one-month period, 260 in-patients, corresponding to 94% of all patients admitted to the hospital, were evaluated. Antibiotics were prescribed for 55.4% of the patients (144/260). The most frequently prescribed antibiotics were first generation cephalosporins (CEF1) 24.6%, aminoglycosides (AMGs) 20.6% and penicillin (PEN) 19.1%.

Antibiotics were used prophylactically in 23.5% (61/144) of the patients. Per patient, the mean number of antibiotics for prophylactic use was 1.4. First generation cephalosporins (52.1%) and penicillins (23.6%) were used most often for prophylaxis. Among those who received prophylactic antibiotics, 15.5 % (11/71) were clinical patients and 84.5 % (60/71) were surgical patients.

Infections were diagnosed in 36% (93/260) of the patients. Among these infections, 54 % (50/93) were community-acquired. The most frequent infections diagnosed were: respiratory (49.5%), skin (16%), infections of gastrointestinal and biliar tracts (11%), infection at the surgical site (11%) and urinary tract infection (8.6%).

The therapeutic use of antibiotics was considered inadequate in 27% of the patients. Antibiotic combinations were used in 43% of the patients. The mean number of therapeutic antibiotics given per patient was 2.1.

Respiratory infections were treated with PEN in 22.5% of the patients. In up to 31% of the cases, the treatment was considered inadequate. The main errors observed were in the use of aminoglycosides in community-acquired pneumonia (20%) and the non-use of antibiotics to treat atypical bacteria (50%).

Treatment of skin infections was considered incorrect in 30% of the patients, because of inadequate coverage for Staphylococcus aureus (30%). The treatment of gastrointestinal and of biliar tract infections was incorrect in 37% of the patients. All urinary tract infections were treated correctly.

The mean of length of hospital stay was 11.9 (14.1) days. Patients treated with antibiotics had a longer length of hospital stay than those who did not receive antibiotics (15.6 and 7.4 days, respectively, $p< 0.001$). The rate of mortality was higher among the patients who received antibiotics when compared with those that had not received antibiotics (16.2 % and 6.9 %, respectively, $p<0.01$).

Evaluation of prophylactic use of antibiotic in surgery

Six hundred and five surgeries conducted during a five-month period were evaluated. This corresponded to 64.6% of the procedures done at the hospital during this period. Some procedures were not evaluated because they were not according to the inclusion criteria.

The majority of the patients were male (70.6%). The mean age of the patients was 47 ± 20 years. The mean length of hospital stay was 11 ± 13 days. The overall rate of mortality was 7.8%. The classification of surgeries performed according to wound risk is shown in Table 1. The surgeries were elective in 73.1% of the total number of procedures.

The infected surgeries accounted for16.2% (98/605) of the total procedures, and they were excluded from prophylaxis analysis. Prophylaxis was indicated in 73.7% of the surgeries. It was not administered in 1.1% of the surgeries for which it was indicated, and it was given unnecessarily in 48 surgeries.

The antibiotics most used for prophylaxis were CEF1, prescribed to 91% of the patients and AMGs, used in 15.9% of the patients. In 78.9% (352/446) of the surgeries, the prophylactic antibiotic used was correctly chosen. In 88,9% (397 /446) of the surgeries, the correct number of dosages of antibiotic was used during the intra-operative period, but in only 15.7% (70/446) of the surgeries the initial antibiotic administration was correctly timed. The use of antibiotics during the post-operative period was appropriate in only 29.8% (133/446) of the cases (Table 2).

During the period of study 4104 g of first generation cephalosporin, 757 g of gentamicin, 183.5 g of metronidazol and 1109 g of ampicillin were considered to be overused.

If we consider all aspects of antibiotic prophylaxis together, prophylaxis was correctly employed in only 23 out of the 446 procedures performed (5.1%). Table 3 presents the errors involved in prophylaxis for the different specialties.

Among the patients studied, 25.8% had at least one diagnosis of infection. The infections were hospital acquired in 56.4% of the patients (105/186).

The mean length of hospital stay [LHS] among patients for whom the choice of prophylactic antibiotics was considered correct was 8.8 +10.9 days, while the mean LHS among those who received inappropriate prophylactic antibiotics was 13.1+12.5 days ($p =0.003$).

The timing for the introduction of antibiotic was not significantly associated with the occurrence of surgical site infection (SSI). The rate of SSI among patients who received the wrong antibiotic was higher than the

Table 1. Surgical procedures classification according to wound risk

	N=605	%
Clean	328	54.2
Clean/contaminated	109	18.0
Infected	98	16.2
Total	**605**	**100.0**

Table 2. Evaluation of different features of antibiotic prophylaxis among 446 surgeries in which it was indicated

	Number (%)
Choice of Atb	
Correct	352 (78.9)
Incorrect	94 (21.1)
Time of starting	
Correct	70 (15.7)
Incorrect	376 (84.3)
Number of doses in the IO	
Correct	397 (88.9)
Incorrect	49 (11.1)
Duration of Atb in the PO	
Correct	133 (29.8)
Incorrect	313 (70.2)

Atb: antibiotic; IO: intra-operative period; PO: post-operative period.

rate of SSI among those who received the correct prophylactic antibiotic (17% and 4.5%, p<0.0001). The prevalence of SSI was also higher among those who used antibiotics during an incorrect period of time in the post-operative period, when compared to those who used antibiotics during the correct time interval (13% and 1.5%, respectively, p<0.001, Table 4). There were no occurrences of SSI in those patients who had received antibiotic prophylaxis considered to be correct in all aspects.

The mean LHS was shorter among patients whose prophylactic treatment was correctly employed than among those whose prophylactic treatment was not [(6.1 +9.8) and 11.1 +13.5, p=0.02].

The overall mortality rate was 7.8%. The mortality rate was significantly higher among those who had SSI than among those who did not (24.6% and 5.7%, respectively; p<0.001) (Table 4). The mean length of hospital stay was also significantly longer among those who had SSI than among those who did not (30.9+19.8 days and 8.6+10.0 days, respectively; p<0.001).

The independent risk factors for SSI, as determined by logistic regression analysis, adjusted to class of

Table 3. Evaluation of prophylactic antibiotics among the procedures in which it was indicated, according to antibiotic choice, time of starting, number of doses in the intra-operative period and duration during the post-operative period, by specialties

Specialties (No. of surgeries with indication of prophylaxis)	Incorrect choice of Atb Nº (%)	Incorrect time of starting Atb Nº (%)	Incorrect no. of doses of Atb in the IO No. (%)	Incorrect duration of Atb in the PO No. (%)
Total (446)	94 (21.1)	376 (84.3)	49 (11.1)	313 (70.2)
Orthopedic (159)	11 (6.9)	110 (69.2)	10 (6.3)	109 (68.4)
Urology (42)	7 (16.7)	39 (92.9)	5 (11.9)	26 (61.9)
Vascular (59)	24 (40.7)	53 (89.8)	10 (16.9)	38 (64.4)
Thorax (14)	13 (92.9)	1 (7.1)	13 (92.9)	
General/gastric (125)	48 (38.4)	123 (98.4)	18 (14.5)	91 (72.8)
Neurology (22)	0 (0)	13 (59.1)	0 (0)	21 (95.5)
Head and Neck (19)	4 (21.1)	19 (100)	3 (18.8)	13 (68.4)
Plastic(6)	0 (0)	6 (100)	2 (33.3)	2 (33.3)

Atb: antibiotic; IO: intra-operative period; PO: post-operative period.

Table 4. Association among different features of antibiotic prophylaxis and surgical site infection

	Surgical Site Infection				
	Yes	No	P	RR	CI 95%
Choice of prophylactic Atb					
Correct	16 (4.5)	336 (95.5)			
Incorrect	16 (17)	78 (83)	<0.001	0.27	0.14– 0.51
Time of starting					
Correct	7 (14.3)	63 (90%)			
Incorrect	25 (6.6)	351 (93.4)	0.07	1.5	0.60–3.40
Number of dose of prophylactic Atb in the IO period					
Correct	25 (6.6)	372 (93.6)			
Incorrect	7 (14.3)	42 (85.7)	0.08	0.44	0.19–1.1
Duration of prophylactic Atb in the PO period					
Correct	2 (1.5)	131 (98.5)			
Incorrect	30 (13.3)	283 (86.7)	0.005	0.15	0.02–0.65

Atb: antibiotic; IO: intra-operative period; PO: post-operative period; CI: confidence interval.

wound risk, were the choice of antibiotic to be used prophylactically and the duration of antibiotic treatment in the post-operative period. Those who received appropriate prophylactic antibiotics had a lower rate of SSI than those who received inappropriate antibiotics [RR (relative risk)=0.49, 95% CI=0.25-0.90)]. Patients who received prophylactic antibiotics correctly in the post-operative period had a lower risk of SSI than those who did not (RR=0.21, 95% CI=0.70-0.63).

Discussion

Pattern of antibiotic use

Several studies have demonstrated that a remarkable amount of antibiotic use in hospitalized patients is excessive or inappropriate [5]. In our study, 54% of hospitalized patients received antibiotics. This figure is similar to the 51.4% prevalence seen in a Greek hospital, as described by Gykas et al. [6]. However, the percentage seen here is lower than the rate found in a Taiwanese hospital (67%) [7]. and it is considerably higher than the rate of 30% presented in a study conducted in The Netherlands [8].

When the appropriateness of therapeutic use was evaluated, it was found that 27% of the patients were treated incorrectly. One of the most important problems detected in our study was the large number of patients who received antibiotic combinations (43%), particularly with the use of aminoglycosides, which are known for their severe side effects. The mean number of antibiotics received by the patients in this study was twice that reported by Berlid (1.2) [9]. These data support the idea that the rate of antibiotic use among hospitalized patients in less developed countries is higher than in more highly developed ones.

Prophylactic antibiotics were prescribed to 15.5% of clinical patients, without any justifying condition; therefore it was consider inappropriate. So it is very important that the true role of prophylaxis, when it is indicated, and the consequences of bacterial resistance when it is used inappropriately, be made known to and understood by the physician.

The higher rate of death among the patients who used antibiotics may be a consequence of serious clinical conditions at the time of hospitalization or of in-hospital events. Our study was not able to evaluate the patients' underlying diseases and the contributions of these diseases to mortality.

The excessive and incorrect use of antibiotics observed in our study may reflect insufficient knowledge among prescribing physicians about differential diagnosis, inaccurate identification of conditions treatable with antibiotics, and inappropriate therapies for bacterial infection, as well as fear of negative clinical outcome in the absence of therapy; this problem needs be addressed in the Marilia Medical School Hospital.

Evaluation of prophylactic use of antibiotics in surgery

In the second phase of our study, antibiotic prophylaxis during surgery was evaluated. We found that this type of treatment is still administered in an incorrect and unnecessary way at the Marilia Medical School Hospital. In 26% of the surgeries, antibiotic prophylaxis was performed even though it was not indicated . The physicians' choices were based on personal preference and tradition in spite of the existence of many guidelines and studies concerning surgical prophylaxis. Our observations in this study were very different from the data reported by Vaisbrud (1999) for a hospital in Israel [10], where it was observed that the indication of antibiotic prophylaxis was wrong in only 3% of the surgeries.

One of the aims of our study was to determine which aspects of antibiotic prophylaxis were the most problematic. It was found that the timing of the administration of antibiotics was incorrect in 84.3% of the cases, and its use in the post-operative periods was incorrect in 70.2% of the cases. There were no striking differences among the specialties. These results are similar to those of many other studies, in which the timing of the administration of antibiotic was found to be one of the main problems in antibiotic prophylaxis. In Taiwan hospitals [11], the rate of incorrect timing of the first dose of antibiotic was 23.8%; in a Dutch

hospital consistency with the recommended timing was 50% [8].

The errors observed in the administration of the first dose were probably related to logistics in the surgical suite, the arrival time in the operating rooms, the type of anesthesia used, and the lack of a clear indication about who is responsible for the administration of prophylaxis. In some patients the first dose of prophylaxis was given in the ward instead of in the operating theatre.

In a study carried out in France by Lallemand [12], prophylaxis was used for an inappropriate length of time in 87.7% of the patients. Gorecki [13] also found excessive duration of prophylaxis in 74% of the patients. These data support the conclusions of our study.

Excessive duration of antibiotic use during the post-operative period may be a consequence of the surgeon's conception of the necessity of providing "extra protection" due to risks from serum lines, tubes or catheters, or because of the impossibility of distinguishing infection from contamination and inflammation from another site.

The goal of prophylactic antibiotic use in surgery is to decrease the rate of SSI. We evaluated the association of different aspects of prophylactic antibiotic treatment with the occurrence of SSI.

The choice of prophylactic antibiotic and inadequate post-operative use of antibiotics were associated with the occurrence of SSI, even when other factors were controlled for by the logistic regression analysis. In studies carried out in Spain [14,15], the timing of antibiotic administration was an independent variable associated with SSI. This was not observed in our study, which may be due to the small number of patients who received antibiotics prophylactically at the right time. Our study did not have the statistical power to detect any differences.

Considering all the aspects of antibiotic prophylaxis for surgical procedures, only 5.1% of the patients were treated correctly. Another Brazilian survey [16] gave similar and alarming data: antibiotic prophylaxis was considered adequate in only 3.0% of the patients. This situation is not exclusive to Brazil. Other countries report similar data. In a university hospital in Barcelona [17], the rate of incorrect use of prophylactic antibiotics was 95%. In Vietnam, a study carried out in 2002 [18] reported that none of the patients received prophylactic antibiotic according to the prevention guidelines. There is reason to believe that the practices observed in our study reflect the state of affairs in many academic centers elsewhere.

The inadequate use of prophylactic antibiotics is associated with longer length of hospitalization. In our study a five day increase in the length of hospitalization was found for patients who received inadequate prophylactic antibiotic treatment. Obviously this had an impact on hospital costs. An economic analysis was not performed as part of our study, but if we consider only the amount of cephalosporin overuse, it would be enough to provide antibiotic prophylaxis to about 1000 new surgical cases.

The correct administration of antibiotic prophylaxis in surgical cases depends on many factors. We noticed that in mostcases, the timing of the administration, and of the use of antibiotics during the post-operative period was inappropriate. Therefore, these are the main aspects that must be addressed in strategies to improve antibiotic prophylaxis at Marilia Hospital.

Many interventions have been attempted to improve therapeutic and prophylactic antibiotic use [19,20]. Restrictive antibiotic authorization forms, requiring approval of antibiotic use by an infectious disease specialist, have already been implemented in Marilia Hospital. The restricted use of more expensive drugs has helped to contain costs, but it may also partially explain the widespread use of non-controlled antibiotics, such as first-generation cephalosporins. Indication for the use of these drugs must be a function of clinical conditions, and the restricted indications for antibiotic combinations need be discussed in the Marilia Medical School Hospital.

Respiratory infections, whether community- or hospital-acquired, were frequent in our study. We observed that they are not handled well in a many cases, so it is necessary that procedures be improved. In order to reach this goal, the help of both the attending physicians and the residents responsible for ordering these medications will be required.

Physician education is an important part of an antibiotic management program. Such education should emphasize outcomes rather than cost, in order to foster physician acceptance of antibiotic-use recommendations [21]. Education-based intervention is most effective when the prescribing physician perceives it is an aid rather than a restriction. Knowledge about existing guidelines and alignment of the guidelines according to current evidence is not enough to guarantee good antibiotic use in either surgical prophylaxis or therapeutic intervention.

In spite of the strong concerns worldwide about how to translate clinical evidence into practice, the best strategies for determining the needs of physicians, both objectively and subjectively, in order to achieve significant adoption of guidelines, have been neither completely nor clearly determined

Testing the feasibility and acceptance of clinical guidelines among surgeons and treating physicians, and trying to achieve consensus before implementing them, is crucial and urgent [22].

Acknowledgements

We thank the hospital employees who helped us with the patient medical records. We also thank FAPESP for financial support.

References

1. World Health Organization. Drug Management Program. Intervention and strategies to improve the use of antimicrobials in developing countries. WHO/CDS/CSR/DRS/**2001**.
2. Ena J. Optimal use of antibiotics. In: Wenzel, R.P. Prevention and control of nosocomial infections. 3rd ed. Baltimore: Williams & Wilkins, **1997**.
3. Kunin C.M. Resistance to antimicrobial drugs- a worldwide calamity. Annals of Internal Medicine **1993**;118,7:557-61.
4. Culver D.H., Horan T.C., Gaynes R.P. et al. Surgical wound infection rates by wound class, operative procedures, and patient risk index. American Journal of Medicine **1991**;91(3b):152s-7s.
5. Wise R. Antimicrobial resistance- is a major threat to public health. BMJ **1998**;317:609-10.
6. Gikas A. Pediaditis J., Papadakis J.A., et al. Prevalence study of hospital-acquired infections in 14 Greek hospitals: planning from the local to the national surveillance level. Journal of Hospital Infection **2002**;50,4:269-75.
7. MC Donald L.C., Yu H. T., Yin H. C., et al. Use and abuse of surgical antibiotic prophylaxis in hospitals in Taiwan. J Formos Med Assoc **2001**;100,1:5-13.
8. Van Kasteren M.E., Kullberg B.J., de Boer A.S., et al. Adherence to local hospital guidelines for surgical antimicrobial prophylaxis: a multicentre audit in Dutch hospitals. J Antimicrob Chemother **2003**;51(6):1389-96.
9. Berlid D., Ringertz S.H., Lelek M. Appropriate antibiotic use according to diagnoses and bacteriological findings: report of 12 point-prevalence studies on antibiotic use in a university hospital. Scandinavian Journal of Infectious Diseases **2002**;34(1): 56-60.
10. Vaisbrud V., Raveh D., Schlesinger Y., et al. Surveillance of antimicrobial prophylaxis for surgical procedures. Infect Control Hosp Epidemiol **1999**;20(9):610-3.
11. Chen Y.S., Liu Y.H., Kunin C.M., et al. Use of prophylactic antibiotics in surgery at a medical center in southern Taiwan. J Formos Med Assoc **2002**;101(11):741-8.
12-. Lallemand S., Thouverez M., Bailly P., et al. Non-observance of guidelines for surgical antimicrobial prophylaxis and surgical-site infections. Pharm World Sci **2002**;24(3):95-9.
13. Gorecki P., Schein M., Rucinski J.C., Wise L. Antibiotic administration in patients undergoing common surgical procedures in a community teaching hospital: the chaos continues. World Journal of Surgery **1999**;23(5):429-33.
14. Munoz P., Jimenez A.J.A., Brea Z.S., Bravo G.P. The effect of surgical antibiotic prophylaxis and the timing of its administration on the risk of surgical wound infection. American Surgery **2000**;66(2):105-11.
15. Fernandez A.H., Monge V., Garcinuno M.A. Surgical antibiotic prophylaxis: effect in post-operative infections. Eur J Epidemiol **2001**;17(4):369-74.
16. Heineck I., Ferreira M.B., Shenkel E.P. Prescribing practice for antibiotic prophylaxis for 3 commonly performed surgeries in a teaching hospital in Brazil. World Journal of Surgery **1999**;23(5):429-32.
17. Delgadillo J., Ramirez R., Cebrecos J., et al. The use of antibiotics in surgical prophylaxis. The characteristics and consequences. Med Clin (Barc) **1993**;20(100)11:404-6.
18. Sohn AH., Parvez F.M., Vu T., et al. Prevalence of Surgical-Site Infections and Patterns of Antimicrobial Use In a Large Tertiary-Care Hospital in Ho-Chi-Min City, Vietnam. Infection Control and Hospital Epidemiology **2002**;23(7):382-7.

19 Jarvis W.R. Preventing the emergence of multidrug-resistant microorganisms through antimicrobial use controls: the complexity of the problem. Infect Control Hosp Epidemiol. **1996**;17(8):490-5.

20. Shales D.M., Gerding D.N., John J.F. Jr, et al. Watanakunakorn 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(3):584-99.

21. Murray B.E. Can antibiotic resistance be controlled? The New England Journal of Medicine **1994**;330(17):1229-30.

22. Davis D.A., Taylor-Vaisey A. Translating guidelines into practice. A systematic review of theoretic concepts, practical experience and research evidence in the adoption of clinical practice guidelines. CMAJ **1997**;157(4):408-16.