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Original Article

Assessment of inappropriate antibiotic use in pediatric patients: Point-prevalence study

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Abstract

Aim: This study aimed to determine inappropriate antibiotic use in a children's hospital using the point-surveillance method.

Material and Methods: One hundred thirteen hospitalized patients were included in the study on the study day. In all patients, data regarding age, sex, antibiotic use, type and dose of antibiotic if used, multiple antibiotic use, presence or absence of consultation with infectious diseases specialist before initiation of antibiotic, form of antibiotic use (empiric, targeted or prophylactic), and reason for antibiotic use were recorded. Inappropriate antibiotic use was determined by an infectious diseases specialist.

Results: The rate of antibiotic use was 70.8%. Of the patients receiving antibiotics, 43% were using more than one antibiotic. It was found that 73.7% of antibiotics were prescribed for empiric purposes and 14.3% for targeted therapy, whereas 12% were prescribed for prophylactic purposes. The rate of inappropriate antibiotic use was 33.8% among patients who were given antibiotics. Unnecessary antibiotic prescription was the most common cause for inappropriate antibiotic use (51.9%), followed by unnecessary multiple antibiotic use (29.6%), inaccurate dosing (11.1%), use of broader spectrum than required (7.4%), and use of antibiotics with narrower spectrum than needed (3.7%). The rate of inappropriate antibiotic use was significantly lower in antibiotics that required confirmation by an infectious diseases specialist (6.7%) than those not requiring confirmation (26.3%; p=0.023). The rate of inappropriate antibiotic use was significantly lower in antibiotics prescribed by infectious diseases specialists (8.6%) than those prescribed by other physicians (26.5%, p=0.027).

Conclusion: Antibiotic use based on consultation with an infectious diseases specialist decreased inappropriate antibiotic use.

Keywords: Antibiotic, inappropriate antibiotic use, point-prevalence study

Introduction

Antibiotics are the most commonly used drug group in hospitalized patients in Turkey as they are all over the world. Inappropriate or unnecessary use of antibiotics leads to adverse effects related with antibiotics, occurence of resistant microorganisms, and increased therapeutic cost (1). With the Budgeting Application Instruction, which entered into force in 2003 for controlling antibiotic use, approval of an infectious disease specialist (IDS) was required for use of some drugs (e.g., karbapenems, glycopeptides, piperacillin-tazobactam, amphotericin B) (2). Thus, it was aimed to decrease inappropriate antibiotic use.

Periodic evaluation of inappropriate antibiotic use is important in terms of revealing problems and taking the necessary precautions. Prevalence studies are cross-sectional studies that can be used to rapidly specify nosocomial infections and evaluate inappropriate antibiotic use (3).

The aim of this study was to determine inappropriate antibiotic use in hospitalized patients in Kayseri Edu-

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cation and Research Hospital, Emel-Mehmet Tarman Children's Hospital, using the point-prevalence method.

Material and Methods

This study was designed as a single-center, point-prevalance study. Local ethics committee approval was obtained for the study (date: 3.3.2017 number: 2017/137). The study was performed in Kayseri Education and Research Hospital, Emel-Mehmet Tarman Children's Hospital, on March 7th, 2017. Kayseri Education and Research Hospital, Emel-Mehmet Tarman Children's Hospital is a tertiary care children's hospital with 166 beds in the Pediatrics Clinic and 18 beds in the Pediatric Surgery Ward. The hospital contains pediatric hematology, pediatric infectious diseases, infant 1 and 2, pediatrics 1 and 2, a pediatric intensive care unit, and pediatric surgery wards. The annual number of hospitalized patients is approximately 8500.

On the day of the study, all patients hospitalized in the wards were included in the study. The pediatric surgery ward was not included in the study because no patients were hospitalized in this ward on the day of study. Infant 1 and 2 wards were evaluated together as infant wards and Pediatrics 1 and 2 wards were evaluated together as pediatrics wards. Data were recorded on a data form. The data form included information related with the patient's age, sex, diagnosis, clinical findings, laboratory findings [complete blood count, procalcitonin, C-reactive protein (CRP)], antibiotic use, reason of the physician for using antibiotic, presence of multiple antibiotic use, name, type (requiring and not requiring approval of an IDS) and dose of the antibiotic used, if opinion of an IDS was received before initiating antibiotic treatment, antibiotic use (empiric, agent-specific, prophylactic), if samples were obtained for culture before antibiotic treatment, and information related with the microorganisms grown in culture. The reason for initiating antibiotic treatment was learned from the physician who followed up the patient. When necessary, cultures, procalcitonin, and complete blood count were ordered and culture results were monitored. The cut-off value in terms of bacterial infection was considered 0.5 ng/mL for procalcitonin and 40 mg/L for CRP (4, 5). Whether inappropriate antibiotic use or type was present was determined through evaluation of the data form by an IDS. The pediatric infectious disease specialist who determined inappropriate antibiotic use was different from the IDS who was in charge of the infectious diseases ward in the period when the study was conducted; both IDSs worked in the same hospital at different times.

Inappropriate antibiotic use was evaluated in subtitles including unnecessary use, wider or narrower than necessary antibiotic spectrum, unnecessary use of multiple antibiotics, and inappropriate antibiotic dose (insufficient or too high). Unnecessary antibiotic use, which was evaluated as a type of inappropriate antibiotic use, was defined as the presence of at least one of following conditions (1):

1. Use of antibiotic in conditions where no infectious disease is found or a viral infection is found when clinical findings, laboratory variables (white blood cell count, neutrophil count, CRP and procalcitonin value), lung imaging, and culture results are evaluated
2. Use of prophylactic antibiotic even though no indication is present
3. Use of antibiotics for longer than necessary

The antibiotics used in the patients were evaluated between themselves according to reasons of inappropriate use. The data were determined by the whole hospital and wards.

Statistical Analysis

The IBM SPSS Statistics for Windows (Version 21.0. Armonk, NY: IBM Corp) statistics program was used for statistical analysis. Incidence data are expressed as percentage (number). Nonparametric data are expressed as median (25-75th percentile). The Chi-square test was used in the comparison of categorical data. For all data, a p value of <0.05 was considered statistically significant.

Results

The total number of patients hospitalized in the wards was 113. The occupancy rate of the wards was 68%. The most common reason for antibiotic use was lung infection (21.3%), followed by sepsis (10%).

The median age of the patients was 22 months (range, 10-80 months). Sixty-two (54.9%) of the patients were male and 51 (45.1%) were female. Among the hospitalized patients, 30.1% (n=34) were in the pediatric wards, 29.2% (n=33) were in the infant wards, 15.9% (n=18) were in the intensive care ward, 12.4% (n=14) were in

the hematology ward, and 12.4% (14) were in the infectious diseases ward.

The antibiotic usage rate was 70.8% (n=80) in the whole hospital. A total of 133 antibiotics were used in the patients who were given antibiotic treatment (n=80). Fourty-three percent of these patients were using multiple antibiotics. Infectious diseases consultation was requested in 22.8% (n=18) of the patients who used antibiotics. In the patients who used antibiotics, the median white blood cell count was found as 10,245 /mm^3 (range, 7572-16,050 /mm^3), the median CRP was found as 13.6 mg/L (range, 3.3-54.2 mg/L), the median procalcitonin level was found as 0.3 ng/L (0.05-2.13 ng/L), and the median neutrophil percentage was found as 58% (range, 35.7%-74%) (Table 1). An increase suggesting bacterial infection was found in the procalcitonin value in 25% of patients in the study group and in the CRP value in 30%. Among the antibiotics used, 22.6% (n=30) required approval of an IDS, 33.8% (45) required approval of an IDS after the first 72 hours (SP-A72), 10.5% (n=14) could be initiated by a specialist physician (SP), and 33.1% (n=44) were in the group that had no limitation (NL). The most commonly used antibiotic was ceftriaxon (18.8%), the second most commonly used antibiotic was ampicillin-sulbactam (12.8%). These were followed by amikacin (10.5%), clarithromycin (9%), trimethoprim-sulfamethoxazole (TMP-SMX) (8.3%), clindamycin (7.5%), meropenem (6.8%), vancomycin (4.5%), cefotaxime (4.5%), cefepime (4.5%), teicoplanin (3%), ceftazidime (2.3%), cefixime (1.5%), fluconazole (1.5%), metronidazole (1.5%), crystallized penicillin (0.8%), colistin (0.8%), caspofungin (0.8%), and piperacillin-tazobactam (0.8%). Ninety-eight (73.2%) of the antibiotics were used empirically, 14.3% (n=19) were used for agent-specific treatment, and 1% (n=16) were initiated with the objective of prophylaxis. In empiric treatment, the most commonly used antibiotic was ceftriaxone (24%), the second most commonly used antibiotic was clarithromycin (12.5%), followed by sulbactam-ampicillin (10.4%). In prophylactic treatment, the most commonly used antibiotic was TMP-SMX (52.9%). In agent-specific treatment, the most commonly used antibiotic was amikacin (22%), the second most commonly used was ampicillin (4%). Only 43.3% of the antibiotics that were included in the scope of IDS (13) and 20% of the antibiotics in the scope of SP-A72 were initiated by an IDS (9).

Samples for culture were obtained before initiating antibiotic treatment in 67.5% (n=54) of the patients who used antibiotics. An agent was isolated in only 33.3% (n=18) of the patients (n=54) in whom antibiotic treatment was initiated and sample for culture was obtained before initiating antibiotic treatment.

The rate of inappropriate antibiotic use was 33.8% (n=27) in the patients who used antibiotics. When all

Table 1. Evaluation of the patients who used antibiotic by wards

	Total (N=80)	Intensive care ward (n=16)	Hematology ward (n=12)	Infectious diseases ward (n=12)	Infant wards (n=20)	Pediatric wards (n=20)
Inappropriate antibiotic use, n (%)	27 (33.8)	0 (0)	4 (33.3)	3 (25)	12 (60)	8 (40)
Obtaining sample for culture before, n (%)	54 (67.5)	16 (100)	10 (83.3)	7 (58.3)	11 (55)	10 (50)
Consultation with division of infectious diseases, n (%)	18 (22.5)	5 (31)	0 (0)	12 (100)	2 (10)	0 (0)
Agent-specific treatment, n (%)	11 (13.8)	5 (31.3)	1 (8.3)	2 (16.7%)	1 (5)	2 (10)
Prophylactic treatment, n (%)	8 (10)	1 (6.3)	4 (33.3)	0 (0)	1 (5)	2 (10)
Empiric treatment, n (%)	61 (76.3)	10 (62.5)	7 (58.3)	10 (83.3)	18 (90)	16 (80)
Use of multiple antibiotics, n (%)	43 (53.8)	14 (87.5)	7 (8.3)	7 (58.3)	10 (50)	5 (25)
PCT (ng/mL)	0.33 (0.05-2.13)	0.9 (0.2-4.5)	0.08 (0.05-0.48)	1 (0.05-4.28)	0.7 (0.2-1.56)	0.05 (0.05-15.2)
CRP (mg/L)	13.7 (3.3-55)	12.7 (5.6-65)	8.7 (3.3-25)	27 (4.8-6.01)	3.3 (3.3-18.95)	11.3 (3.3-54.2)
WBC (x10^3/mm^3)	10.3 (7.59-16)	10.5 (6.4-15.7)	8 (3.72-28.17)	10.95 (8.74-14.18)	11.19 (8.55-15.3)	10.07 (7.67-17.07)
Neutrophil (%)	58 (36-74)	42 (68-75)	38 (4-73)	65 (52-76.2)	4.14 (28-65)	56 (38-65)

CRP: C-reactive protein; PCT: procalcitonin; WBC: white blood cell count

Table 2. Evaluation of inappropriate antibiotic use by wards

	Total (N=27)	Intensive care ward (n=0)	Hematology ward (n=4)	Infectious diseases ward (n=3)	Infant wards (n=12)	Pediatric wards (n=8)
Inappropriate antibiotic use, n (%)	13 (51.9)	0 (0)	1 (25)	1 (8.3)	6 (30)	5 (25)
Use of antibiotics at inappropriate doses, n (%)	3 (11.1)	0 (0)	0 (0)	1 (8.3)	1 (5)	1 (5)
Unnecessary use of multiple antibiotics, n (%)	8 (29.6)	0 (0)	1 (25)	1 (8.3)	5 (25)	1 (5)
Use of antibiotics with a spectrum narrower than necessary, n (%)	1 (3.7)	0 (0)	1 (25)	0 (0)	0 (0)	1 (5)
Use of antibiotics with a spectrum broader than necessary, n (%)	2 (7.4)	0 (0)	1 (25)	0 (0)	0 (0)	1 (5)

patients who used antibiotics inappropriately were evaluated, the most common reason for inappropriate use was found to be antibiotic use in the absence of necessity (51.9%). This was followed by unnecessary use of multiple antibiotics (29.6%), administration of incorrect dose (11.1%), use of antibiotics with a spectrum wider than necessary (7.4%), and use of antibiotics with a spectrum narrower than necessary (3.7%) (Table 2). Empiric antibiotic use was present in 92.6% of patients who used antibiotics inappropriately and prophylactic antibiotic use was present in 7.4%. Inappropriate antibiotic use was not found in patients who were given agent-specific antibiotic treatment. The most common inappropriate antibiotic use was found in patients who were diagnosed as having lung infections (29.6%).

The most common antibiotic that was used inappropriately was clarithromycin (50%). This was followed by ceftriaxone (36.4%) and ampicillin (35.4%). The only antibiotic used at an inappropriate dose was ceftriaxone. Although the severity of infection was not high in these patients, ceftriaxone was used at a dosage of 100 mg/kg/day. In unnecessary use of multiple antibiotics, the most common was clarithromycin (50%). The rate of inappropriate antibiotic use was found as 6.7% for the antibiotics that were included in the scope of IDS (n=30) and 26.2% for antibiotics that were not included in the scope of the IDS (n=103). The rate of inappropriate antibiotic use was found to be statistically significantly higher for antibiotics that were not included in the scope of the IDS (p=0.023).

The rate of inappropriate antibiotic use was found as 8.6% for antibiotics initiated by an IDS (n=35) and 26.5% for those initiated without consulting an IDS (n=98). The rate of inappropriate antibiotic use was found to be statistically significantly lower for antibiotics initiated by an IDS (p=0.027).

When the rate of antibiotic use was evaluated by wards, it was found that antibiotics were most commonly used in the intensive care ward (88.9%). This was followed by the pediatric hematology ward (85.7%), infectious diseases ward (85.7%), infant wards (60.6%), and pediatric wards (55.9%). Multiple antibiotics were used most commonly in the intensive care ward (87.5%). Obtaining samples for culture before antibiotic treatment (100%), consultation with the department of infectious diseases before antibiotic treatment (31%), use of multiple antibiotics (87.5%), and agent-specific treatment (31.3%) were most commonly observed in the intensive care ward. Prophylactic treatment was used most commonly in the hematology ward (25%). Antibiotic use initiated by an IDS most commonly occured in the intensive care ward (48.5%). This was followed by the hematology ward (37.5%), infant wards (19%), and infectious diseases ward (9.5%). No antibiotic treatment was initiated by an IDS in the pediatric wards. Inappropriate antibiotic use occured with a rate of 60% in the infant wards, 40% in the pediatric wards, 33.3% in the hematology ward, and 25% in the infectious diseases ward. No inappropriate antibiotic was observed in the intensive care ward (Table 1).

Discussion

In our study, the rate of inappropriate antibiotic use was found to be similar to the literature. The most common reason for inappropriate use was found to be antibiotic use in the absence of antibiotic necessity or excessive use of multiple antibiotics. It was found that inappropritate use was higher for antibiotics that did not require approval of an IDS and lower for the antibiotics that were initiated by an IDS.

In the study conducted by Devrim et al. (3) in a children's hospital, inappropriate antibiotic use was found as 12.9% in pediatric wards, whereas it was 57.1% in pediatric surgery wards. Inappropriate antibiotic use was found with a rate of 40.7% in a study conducted by Azap et al. (6) in a university hospital and as 49% in a study by Yılmaz et al. (1) in an education and research hospital. In our study, we found inappropriate antibiotic use at a rate of 33.8% which was similar to the literature.

Inappropriate antibiotic use may show variance in different divisions or wards of the same hospital. Studies have shown that inappropriate antibiotic use occurs more frequently in surgery wards compared with internal medicine wards (3, 6). Inappropriate antibiotic use has been reported with a high rate in pediatric intensive care wards (7). However, we found that the rate of inappropriate antibiotic use was lower in the intensive care ward in our study, in contrast to the literature. This may be related with the higher rate of obtaining samples for culture and higher rate of consultation with the division of infectious diseases in intensive care. In our country, the use of broad-spectrum antibiotics was limited with antibiotic prescription rules included in the Budgeting Application Instruction which entered into force in 2003 (2). In the study conducted by Devrim et al. (3), the rate of inappropriate antibiotic use was found to be statistically significantly lower in patients for whom consultation was requested from the division of pediatric infectious diseases. In our study, the rate of inappropriate antibiotic use was found to be lower for antibiotics that required approval of an IDS and in patients for whom consultation was requested from the division of infectious diseases.

Another important issue is obtaining appropriate samples from the focus of infectious for Gram staining and culture and antibiogram before initiating antibiotic treatment. In our study, the rate of obtaining samples for culture before initiating antibiotic treatment was low. The rates of inappropriate antibiotics that were initiated according to culture results were considerably lower compared with prophylactic and empiric treatment. In the studies conducted by Azap et al. (6) and by Devrim et al. (3), inappropriate antibiotic use was not found in patients in whom treatment was initiated according to microbiologoic data. Similarly, inappropriate antibiotic use was not found in any of the patients in whom agent-specific antibiotic treatment was initiated in our study.

Generally, antibiotics are used in three ways; in the presence of a proven infection, as empric treatment, and as prophylactic treatment (8). Before initiating empirical treatment, need for antibiotic treatment should be determined accurately according to the patient's clinical and laboratory findings, the spectrum of the antibiotic initiated should not be broader or narrower than necessary, and unneccessary treatment with multiple antibiotics should be avoided. The reason of inappropriate antibiotic use may vary according to the characteristics of clinics. In the study conducted by Ertuğrul et al. (9) in surgery wards, the most common reason for inappropriate antibiotic use was found to be prolonged prophylaxis. In the study conducted by Devrim et al. (3) in a children's hospital, inappropriate antibiotic use was found with a higher rate for antibiotics given with the objective of prophylaxis compared with empiric use. In a study conducted by Yılmaz et al. (1) in an education and research hospital, inappropriate antibiotic use was found with a higher rate in patients who were given empiric antibiotic treatment. In our study, inappropriate antibiotic use was found most frequently in patients in whom empiric treatment was initiated.

In our study, the second most common reason for inappropriate antibiotic use was unnecessary use of multiple antibiotics. The most commonly used antibiotic in inappropriate antibiotic use was clarithromycin. Clarithromycin was used in the scope of unnecessary use of multiple antibiotics in patients with lung infections or conditions for which antibiotic treatment was not needed. Guidelines may be used to decrease inappropriate antibiotic use in patients with lung infections. Several of these guidelines include the Diagnostic and Therapeutic Consensus Reports for Pediatric Community-acquired Pneumonia and Nosocomial Pneumonia published by the Turkish Thoracic Society in 2009 (10). The second most commonly used antibiotic in inappropriate antibiotic use was ceftriaxone. It was observed that ceftriaxone was initiated at a dosage of 100 mg/kg/day, although clinically severe infection was not present. Physicians should evaluate findings of severe infection accurately and avoid use of high-dose antibiotics in conditions when it is unnecessary. In this way, incidences of resistance and adverse effects will be reduced (11).

Accurate use of antibiotics means administration of efficient and safe antibiotics when necessary (12). In all developed countries, it has been aimed to establish antibiotic control teams and hospital drug lists to provide appropriate antibiotic use (11). One primarily has to have data related with antibiotic consumption in order to make any recommendation in terms of any intervention in the policies of antibiotic use throughout the hospital. Repeated local feedback and survaillance analyses on the issue of antibiotic use may provide an increase in awarenes of appropriate antibiotic use (13). The fact that limitation precautions related with antibiotic use are not adequate and consultations with IDSs are rarely made in our hospital is another reason that increases inappropriate antibiotic use in empiric treatment. It is clear that the use of antibiotics according to consultation with the division of infectious diseases is a variable that decreases the frequency of inappropriate antibiotic use. However, inappropriate antibiotic use was found with a higher rate for antibiotics for which no limitations were established and approval of an IDS was not required.

A limitation of our study was the fact that inappropriate antibiotic use was determined with an instantaneous evaluation based on the clinical, laboratory, and culture results of the patients, because it was designed as a point-prevalence study. This might have caused erroneous evaluation of the conditions where the decision of initiating antibiotic use was made by physicians, excluding those where a significiant agent was grown in cultures that were included in some widely accepted therapeutic and prophylaxis guidelines. Therefore, more accurate results can be obtained in the issue of inappropriate antibiotic use with studies with prospective designs. Another limitation was the fact that the decision of inappropriate antibiotic use was made by a single physician. However, the fact that inapropriate antibiotic use was determined by a pediatric IDS and the determinative physician was different form the pediatric IDS who was in charge of treatment and consultation for hospitalized patients might have provided objectivity.

In conclusion, inappropriate antibiotic use is frequently observed in many hospitals. Intermittent point- prevalence studies are helpful in terms of demonstrating possible problems related with antibiotic use and taking necessary precautions. It is clear that use of antibiotics according to consultation with the division of infectious diseases is a variable that decreases the frequency of inappropriate antibiotic use.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Erciyes Universtiy School of Medicine Clinical Researches (no: 2017/137)

Informed Consent: Written informed consent was not obtained from patients due to the retrospective nature of the study.

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References

1. Yılmaz EM, Atilla A, Demirhan B, İmdat S, Kılıç SS. Samsun Eğitim ve Araştırma Hastanesi'nde antibiyotik kullanımına ilişkin nokta prevalans çalışması. ANKEM Derg 2013; 27: 124-9.
2. Şardan ÇY. Antibiyotik kontrol komitesinin işlevi ve kontrollü antibiyotik kullanımı. ANKEM Derg 2004; 18: 56-8.
3. Devrim İ, Gülfidan G, Tavlı V, ve ark. Dr. Behçet Uz Çocuk Hastanesi'nde antibiyotik kullanımına ilişkin nokta prevalans çalışması. *Çocuk Enfeks Derg* 2009; 3: 11-3.
4. Putto A, Meurmanhttp://www.nature.com/pr/journal/v19/n10/abs/pr19852710a.html?foxtrotcallback=true - aff1 O, Ruuskanen O. C-reactive protein in viral and bacterial infections. Pediatric Research 1985; 19: 1103. [CrossRef]
5. Meisner M. Update on procalcitonin measurements. Ann Lab Med 2014; 34: 263-73. [CrossRef]
6. Azap A, Memikoğlu KO, Çokça F, Tekeli E. Bir üniversite hastanesinde bütçe uygulama talimatı öncesinde ve sonrasında antibiyotik kullanımı. Flora 2004; 9: 252-7.
7. Blinova E, Lau E, Bitnun A, et al. Point prevalence survey of antimicrobial utilization in the cardiac and pediatric critical care unit. Pediatr Crit Care Med 2013; 14: 280-8. [CrossRef]
8. Tartar AS, Denk A, Özden M, Kırık YÇ, Akbulut A, Demirdağ K. Fırat Üniversitesi Hastanesi'nde antibiyotik kullanımı uygunluğunun araştırılması: nokta prevalans çalışması. Ankem Derg 2015; 29: 16-20.

9. Ertuğrul MB, Özgün H, Saylak MÖ, Sayım N. Bir üniversite hastanesi cerrahi servislerinde antibiyotik kullanımı ve maliyeti: Bir günlük nokta prevalansı çalışması. Klimik Derg 2009; 22: 44-7.
10. Kocabas E, Ersöz DD, Karakoc F, ve ark. Çocuklarda toplumda gelişen pnömoni tanı ve tedavi uzlaşı raporu. Türk Toraks Dergisi 2009; 10: 6-9.
11. Saçar S, Kavas ST, Asan A, Cenger DH, Turgut H. Pamukkale Üniversitesi Tıp Fakültesi Hastanesinde antibiyotik kullanımına ilişkin nokta prevalans çalışması. ANKEM Derg 2006; 20: 217-21.
12. Şardan Çetinkaya Y. Antibiyotik kullanımında temel ilkeler. İçinde: Uzun Ö, Ünal S, (yazarlar). Güncel bilgiler ışığında enfeksiyon hastalıkları. Ankara: Bilimsel Tıp Yayınevi; 2001.p.93-102.
13. Skoog G, Struwe J, Cars O, et al. Repeated nationwide point-prevalence surveys of antimicrobial use in Swedish hospitals: data for actions 2003-2010. Euro Surveill 2016; 23; 21. [CrossRef]