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Dynamics of antimicrobial consumption in an inpatient surgical department following the implementation of an antimicrobial stewardship programme

Abstract

Relevance. Antimicrobial stewardship (AMS) programmes have become an important strategy for optimising antibiotic use and combating antimicrobial resistance in surgical practice.

Aim. To evaluate the impact of implementing an AMS on antibiotic consumption in an inpatient surgical department.

Materials and methods. A retrospective analysis of antimicrobial consumption was conducted in the surgical department of a university hospital between 2023 and 2025. Consumption was assessed using the defined daily dose (DDD) and DDD per 100 bed-days, with analysis of the prescribing structure according to the WHO AWaRe classification.

Results. Despite an almost fivefold increase in the total volume of antibiotics used, from 558.1 to 2,387.0 DDD, due to a substantial expansion of surgical services, including the treatment of patients with combat-related injuries, the intensity of antibiotic consumption decreased from 33.5 to 6.8 DDD per 100 bed-days. The proportion of Access group antibiotics increased from 5.8% to 57.3%, whereas the proportion of Reserve group antibiotics declined from 82.6% to 4.7%, indicating a more appropriate pattern of use. A marked reduction was observed in the prescribing of third-generation cephalosporins (particularly ceftriaxone, which is classified as a Reserve antibiotic according to the national healthcare standard), as well as other Reserve antibiotics, including colistin and tigecycline. The use of carbapenems and fluoroquinolones also decreased, while the use of aminoglycosides, metronidazole, and clindamycin, all of which belong to the Access group, increased.

Practical significance. The implementation of a comprehensive AMS resulted in more rational antibiotic use, optimisation of prescribing patterns in accordance with the AWaRe classification, and a reduction in the intensity of antibiotic consumption, confirming the effectiveness of a multidisciplinary approach involving a clinical pharmacist in the inpatient surgical setting.

Keywords: antimicrobial resistance; clinical pharmacist; antibiotics; surgery; medicine consumption; defined daily dose; AWaRe classification.

INTRODUCTION

The rational use of antibiotics in surgery is not only a matter of clinical protocol but also a strategic objective for ensuring global safety. Surgical wards are high-risk areas where the consumption of antimicrobial medicines is traditionally high, both for prophylaxis and for the treatment of complex infections; therefore, for a

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surgeon, an antibiotic is not merely a medicine but a critical tool for the success of a surgical procedure. This is primarily because antimicrobial resistance (AMR) is recognised as one of the most serious threats to global public health and economic stability.

The principal driver of this problem is the excessive and inappropriate use of antibiotics. According to Y. Wang *et al*. [1], between 20% and 50% of antimicrobial prescriptions in hospitals are inappropriate or unnecessary. Thus, taking into account these findings, as well as those reported by I. Kourbeti *et al*. [2], the rational use of antibiotics is recognised as a key strategy for limiting the spread of AMR. M. Bashar *et al*. [3] reported that surgical site infections (SSIs) remain a leading cause of postoperative morbidity and mortality, prompting surgeons to prescribe broad-spectrum antibiotics for prolonged periods. However, it has been demonstrated that extending surgical antibiotic prophylaxis beyond 24 hours does not reduce the risk of infection but significantly increases the likelihood of adverse events, including acute kidney injury and *Clostridioides difficile* infection. A. Marino *et al*. [4] demonstrated that surgical antimicrobial prophylaxis is essential for preventing SSIs, although inappropriate antibiotic use remains a major challenge. M. Piscaglia *et al*. [5] found that patients with SSIs were significantly more likely to develop additional healthcare-associated infections. Similarly, H. Habteweld *et al*. [6] reported that inappropriate antibiotic selection or unnecessarily prolonged treatment significantly increases the risk of adverse surgical outcomes.

To address these challenges, antimicrobial stewardship (AMS) programmes have been implemented worldwide. The primary objective of these programmes is to optimise clinical outcomes while minimising the risks associated with antibiotic use, including toxicity and the selection of resistant bacterial strains. According to Y. Wang *et al.* [1], in the surgical setting this involves the adoption of de-escalation strategies, whereby empirical broad-spectrum antibiotic therapy is replaced with targeted narrow-spectrum treatment guided by microbiological findings. The effectiveness of such programmes largely depends on a multidisciplinary approach. Evidence indicates that the involvement of clinical pharmacists in daily ward rounds and prescription audits significantly reduces antibiotic consumption and hospitalisation costs in surgical departments [1]. Likewise, the implementation of the "handshake stewardship" model, based on direct communication between the AMS team and treating physicians, has demonstrated high effectiveness in general surgical units. As reported by A. Kosharek *et al.* [7], this approach not only reduces antibiotic consumption but also improves prescribing quality.

The assessment of antimicrobial consumption is generally based on the calculation of defined daily doses (DDD). A study conducted by M. Bashar *et al*. [3] in South Africa demonstrated that the systematic implementation of AMS in surgical departments resulted in a sustained reduction in DDD per 1,000 bed-days, accompanied by an increased proportion of targeted antimicrobial therapy. A. Jover-Sáenz *et al*. [8] emphasised that a considerable proportion of inappropriate antibiotic prescribing occurs during the transition from inpatient to outpatient care, and that interventions aimed at optimising antimicrobial therapy during this stage can reduce treatment duration by 40% or more.

The implementation of AMS is particularly important in surgical intensive care units. J. Yu *et al.* [9] demonstrated in a neurosurgical intensive care unit that active intervention by a multidisciplinary stewardship team substantially reduced the use of last-resort antibiotics, including polymyxins and tigecycline, while improving the susceptibility of Gram-negative bacteria to antipseudomonal β-lactam antibiotics. C. Pallares *et al.* [10] likewise reported that the implementation of AMS in tertiary-care hospitals reversed unfavourable resistance trends in *Pseudomonas aeruginosa* and *Escherichia coli*. Despite these successful examples, the implementation of AMS remains challenging in many countries because of shortages of trained personnel, the absence of national guidelines, and cultural barriers within the medical community.

The aim of this study was to analyse changes in antibiotic consumption following the implementation of an antimicrobial stewardship programme in the inpatient surgical department of a university hospital.

MATERIALS AND METHODS

A retrospective analysis of antibiotic consumption was conducted in the inpatient surgical department of the University Hospital of the O.O. Bogomolets National Medical University between 2023 and 2025. From 2024 onwards, the surgical department experienced a substantial increase in clinical activity owing to the provision of surgical care for patients with combat-related injuries. This was accompanied by an expansion in the range of surgical procedures performed. In 2025, the spectrum of surgical interventions continued to expand, while the number of patients requiring treatment for severe infections also increased. During the study period, several AMS interventions were implemented, including pre-authorisation of Reserve antibiotics, the introduction of a new local protocol for perioperative antibiotic prophylaxis, a series of educational workshops on the rational use of antimicrobial agents for perioperative prophylaxis and antibiotic therapy, and prospective audit with feedback, during which a clinical pharmacist provided consultations aimed at optimising the duration of antimicrobial therapy and perioperative antibiotic prophylaxis. The pre-authorisation process required selected antimicrobial agents (including carbapenems, polymyxins, ceftazidime/avibactam, cefiderocol, linezolid, daptomycin, ceftriaxone, and levofloxacin) to be prescribed only after approval by a clinical pharmacist from the Infection Prevention and Control Department. Each request was assessed with regard to the appropriateness of the prescription for the clinical diagnosis, compliance with current clinical guidelines, microbiological findings or the presence of risk factors for infections caused by multidrug-resistant microorganisms, previous antibacterial therapy, the appropriateness of the prescribed dose, route of administration and treatment duration, renal and hepatic function, and potential drug interactions. Following expert review, either approval for the requested antimicrobial agent was granted or an alternative treatment regimen was recommended.

The overall consumption of antimicrobial agents, the consumption of individual antimicrobial medicinal products and specific groups of antibiotics, including analyses according to the WHO AWaRe classification, was assessed in DDDs per 100 bed-days. For each antibiotic, the total amount of active substance used annually in 2023, 2024 and 2025 was determined. Current DDD values were assessed based on the use of the ATC/DDD index. To determine the number of DDDs, the total quantity of the antimicrobial medicinal product consumed was divided by its ATC/DDD index value. To determine the relative consumption of antibiotics, the quantity of antimicrobial medicine consumed in DDDs was calculated per 100 bed-days using the formula: DDD/100 bed-days = Total number of DDDs × 100/Number of bed-days. The study did not require ethical approval. Artificial intelligence was used exclusively for technical editing of the manuscript, in particular to standardise and format the reference list in accordance with the journal's requirements, as well as to make linguistic, stylistic and editorial amendments. The generation, analysis and interpretation of scientific data, the formulation of conclusions and the final approval of the manuscript's content were carried out by the authors themselves.

RESULTS AND DISCUSSION

According to the data presented in Table 1, total antibiotic consumption over the two-year period increased significantly by almost fivefold (from 558.1 DDD in 2023 to 2,387.0 DDD in 2025), but the total number of bed-days increased by more than twentyfold (from 1,667 bed-days to 34,916 bed-days); as a result, total antibiotic consumption per 100 bed-days fell by almost a factor of 5 (from 33.5 to 6.8 DDD/100 bed-days).

Table 1. Overall consumption of antimicrobial agents at the National Medical University Hospital, 2023-2025

Antimicrobial agent consumption	Years		
	2023	2024	2025
Total consumption, DDD	558.1	1,387.7	2,387.0
Number of bed-days	1,667	28,169	34,916
Total consumption, DDD/100 bed-days	33.5	4.9	6.8

Source: data from the clinic's statistical report

In 2023, Access antibiotics accounted for 5.8% of total antimicrobial consumption, while Watch and Reserve antibiotics represented 11.6% and 82.6%, respectively. Following the implementation of the AMS in 2024, the proportion of Access antibiotics increased to 78.0%, whereas the proportions of Watch and Reserve antibiotics declined to 4.6% and 17.4%, respectively. In 2025, the predominance of Access antibiotics was maintained (57.3%), accompanied by an increase in the proportion of Watch antibiotics to 38.0% and a further reduction in the consumption of Reserve antibiotics to 4.7% (Table 2).

Table 2. Structure of antimicrobial consumption at the National Medical University Hospital according to the WHO AWaRe classification, 2023-2025

AWaRe antimicrobial group	Years		
	2023	2024	2025
Access, %	5.8	78.0	57.3
Watch, %	11.6	4.6	38.0
Reserve, %	82.6	17.4	4.7

Source: data from the clinic's statistical report

According to the data presented in Table 3, the implementation of the AMS in the surgical department was associated with a substantial reduction in the consumption of cephalosporins and carbapenems among β-lactam antibiotics. In contrast, the use of broad-spectrum penicillins, including β-lactam/β-lactamase inhibitor combinations, was introduced. A marked decrease was also observed in the use of fluoroquinolones and Reserve antibiotics used to treat resistant Gram-negative infections, particularly tigecycline and colistin. Conversely, aminoglycosides, which belong to the Access group, were introduced into routine practice. In addition, antibiotics targeting Gram-positive infections, including the Access antibiotics clindamycin and metronidazole, as well as the Watch antibiotics vancomycin and lincomycin, began to be prescribed more frequently.

Table 3. Consumption of individual groups of antimicrobial agents in the surgical department, expressed as DDD per 100 bed-days, 2023-2025

Antimicrobial group/agent	Antimicrobial consumption, DDD per 100 bed-days		
	2023	2024	2025
β-Lactam antibiotics (with and without β-lactamase inhibitors)			
Amoxicillin			0.027
Piperacillin			0.017
Cefazolin	1.955189	3.757	2.748
Cefuroxime	2.285063	0.000	0.029
Ceftriaxone	12.04799	0.110	0.006
Cefotaxime	0		0.011
Ceftazidime	0		0.004
Meropenem	0.113977	0.146	0.023
Amoxicillin/clavulanic acid	0		0.045
Piperacillin/tazobactam	0		0.012
Ceftazidime/avibactam	0	0.030	
Meropenem/vaborbactam	0	0.039	
Fluoroquinolones	0		
Ciprofloxacin	0.988722	0.029	0.090
Levofloxacin	2.887403	0.454	0.077
Moxifloxacin	0.25189		
Macrolides	0		
Azithromycin	0		0.029
Clarithromycin	0		0.115
Tetracyclines	0		
Doxycycline	0		0.057
Tigecycline	0.233893	0.036	0.189
Aminoglycosides	0		
Gentamicin	0		9.547
Tobramycin	0		1.031
Amikacin	0		0.034
Glycopeptides	0		
Vancomycin	0		0.013
Lincosamides	0		
Clindamycin	0		0.033
Lincomycin	0		0.010
Nitroimidazoles	0		
Metronidazole	0		0.254
Polymyxins	0		
Colistin	0.19832	0.063	

Source: ata from the clinic’s statistical report

the findings of the study, the implementation of the AMS programme at the clinic was aimed at reducing and optimising the pattern of antibiotic use, in particular using the WHO AWaRe classification. In their systematic reviews, L. Naseralallah *et al.* [11] and J. Martinez-Sobalvarro *et al*. [12] concluded that AMSs improve antibiotic prescribing practices, reduce the incidence of surgical infections, and optimise the duration of perioperative antibiotic therapy. Similarly, the systematic review by I. Sefah *et al*. [13] demonstrated that AMS interventions improve adherence to clinical guidelines while reducing expenditure on antibiotics. M. Bashar *et al*. [3], A. Kosharek *et al*. [7], and A. Jover-Sáenz *et al.* [8] reported reductions in antibiotic consumption of 24-53% following the implementation of AMSs in surgical departments. Furthermore, A. Jover-Sáenz *et al*. [8] demonstrated that pharmaceutical care facilitated a successful transition from intravenous to oral antibiotic therapy for urological infections, thereby improving continuity of care between inpatient and outpatient settings. This approach enabled appropriate completion of treatment at home without unnecessary days of parenteral therapy, minimised errors in treatment duration, and reduced post-discharge antibiotic prescribing in surgical patients by approximately 60%. M. Batlle *et al*. [14] also demonstrated that a surgery-specific AMS focused on prolonged antimicrobial therapy significantly reduced the number of antibiotic courses lasting seven days or longer in surgical patients with infections.

In the present study, interventions aimed at optimising treatment duration resulted in an almost fivefold reduction in antibiotic consumption expressed as DDD per 100 bed-days. The AMS included the involvement of a clinical pharmacist in both the pre-authorisation of Reserve and Watch antibiotics (particularly during 2024) and prospective audit with feedback for prolonged antibiotic therapy and the use of Reserve antibiotics, including ceftriaxone. Y. Liu *et al*. [15] and B. Okposio *et al.* [16] highlighted the importance of multidisciplinary collaboration in improving antimicrobial prescribing protocols and combating antimicrobial resistance in surgical practice. Likewise, A. Kosharek *et al.* [7] emphasised the value of collaboration between infectious diseases specialists and clinical pharmacologists or clinical pharmacists, who jointly conducted prescribing audits and discussed recommendations directly with the surgical team. Such an approach promotes greater clinician engagement, enhances trust, and facilitates individualised antimicrobial therapy. Evidence consistently supports the superiority of multidisciplinary, interactive stewardship models over purely restrictive interventions. A. Kosharek *et al*. [7] further reported that AMS implementation reduced the Antibiotic Spectrum Index from 2,839 to 2,519, reflecting successful antimicrobial de-escalation and optimisation of therapy. The effectiveness of prospective audit with feedback in surgical practice is attributable to its ability to tailor general recommendations to the individual patient's clinical condition and the complexity of the surgical procedure. Moreover, following implementation of the AMS, the incidence of *Clostridioides difficile* infection declined from 2.1% to 0%, providing further evidence of the safety of strategies based on treatment shortening and antimicrobial de-escalation. In addition, a substantial reduction in the average cost of treatment was observed.

According to G. Surat *et al.* [17], O. Pechak *et al*. [18], and G. Betito *et al.* [19], inappropriate or unnecessary postoperative antibiotic prophylaxis can be substantially reduced or eliminated, primarily through the revision of institutional protocols and the reinforcement of evidence-based recommendations. In the present study, significant improvements in perioperative antibiotic prescribing were achieved following the implementation of a new local protocol for perioperative antibiotic prophylaxis. This was accompanied by a marked reduction in the use of Reserve and Watch antibiotics with activity against Gram-negative pathogens, including colistin, tigecycline, ceftazidime, ceftriaxone, meropenem, ciprofloxacin, levofloxacin, and moxifloxacin. Similar findings have been reported by J. Díaz-Madriz *et al.* [20], G. Wu *et al.* [21], and O. Pechak *et al*. [18], who demonstrated a shift from broad-spectrum to narrow-spectrum cephalosporins for both prophylaxis and treatment, particularly an increased use of cefazolin accompanied by reduced prescribing of ceftriaxone and fourth-generation cephalosporins. M. Bashar *et al*. [3] further confirmed that AMS implementation not only reduces overall antibiotic consumption but also improves the appropriateness of antimicrobial therapy through prescribing guided by microbiological culture results. In their study, increased use of piperacillin/tazobactam reflected the rising prevalence of *Pseudomonas aeruginosa* infections. In addition, they reported the discontinuation of unnecessary postoperative use of amoxicillin/clavulanic acid, which is frequently continued without indication after surgery, in favour of cefazolin with prophylaxis limited to a maximum of 24 hours. They also observed a reduction in the use of fluoroquinolones and third-generation cephalosporins because of their association with the selection of resistant *Enterobacteriaceae*.

The present study also demonstrated an increased use of aminoglycosides, which are classified as Access antibiotics according to the WHO AWaRe classification, reflecting the preserved susceptibility of multidrug-resistant Gram-negative pathogens to this class of antibiotics. M. Thy *et al.* [22] likewise emphasised that aminoglycosides remain important bactericidal agents against resistant Gram-negative bacteria, including multidrug-resistant and carbapenem-resistant strains. S. Story *et al.* [23] reported that combination therapy incorporating aminoglycosides with other antibacterial agents provides synergistic activity that may help overcome resistance in extensively drug-resistant Gram-negative organisms. Furthermore, S. Goutelle *et al.* [24] proposed optimised aminoglycoside dosing regimens to improve both efficacy and safety, including the use of a fixed initial dose of 2,500 mg of amikacin to simplify dosing in emergency surgical patients.

Nevertheless, several important barriers continue to hinder the implementation of AMS in surgical practice. Resource limitations remain a major challenge, as prospective audit with feedback requires the continuous involvement of infectious diseases specialists and clinical pharmacists, which may not be feasible in many non-academic hospitals. Although overall adherence to stewardship recommendations has been reported to range between 71% and 72%, successful implementation is often constrained within surgical teams. Recommendations communicated to junior doctors or nursing staff may be overridden by senior consultants who were not directly involved in the AMS. As reported by S. Cabral *et al.* [25], adherence to antimicrobial stewardship recommendations remains suboptimal even in high-income countries.

The authors developed and implemented a series of training sessions for doctors, particularly junior doctors, on current issues relating to surgical antibiotic prophylaxis and antibiotic therapy. M. Bashar *et al*. [3] emphasise the importance of involving surgical residents in weekly discussions on approaches to antimicrobial therapy, as this is critical for changing the culture of prescribing. Training directly at the patient's bedside transforms the younger generation of doctors' approach to antibiotic therapy. J. Díaz-Madriz *et al.* [20] point out that even in the absence of strict administrative restrictions, a strategy of training and feedback can alter patterns of consumption; for example, by replacing the excessive use of ceftriaxone with the more rational use of cefazolin in surgical prophylaxis.

Among the common problems is the inappropriate use of vancomycin, which can increase the incidence of adverse effects, such as acute kidney injury. According to the study's findings, vancomycin consumption remains negligible (0.013 DDD/100 bed-days), as it is restricted solely to cases where a patient is at risk of infection caused by methicillin-resistant Staphylococcus aureus (MRSA). Consequently, a strategic approach to the use of antimicrobials in surgery must be based on the principle of reducing the duration of therapy to the minimum necessary; this is key to the environmental safety of the hospital and the clinical effectiveness of treatment. It is important to ensure direct collaboration between the clinical pharmacist and the surgeon through the use of prospective audits with feedback; to move away from fixed-dose regimens towards individualised dose calculations, ensuring that patients receive the exact amount of medication.

CONCLUSIONS

1. The implementation of an AMS in the inpatient surgical department demonstrated high effectiveness in optimising antibiotic therapy and the pattern of antimicrobial consumption. Despite a substantial increase in the number of hospital admissions and bed-days, the intensity of antibiotic use decreased almost fivefold, indicating a marked improvement in the appropriateness of antibiotic prescribing. The implementation of a comprehensive stewardship strategy, including pre-authorisation of Reserve antibiotics, the introduction of a local protocol for perioperative antibiotic prophylaxis, clinician education, and prospective audit with feedback involving a clinical pharmacist, contributed to more appropriate use of antibacterial agents.

2. Following the implementation of the AMS, the proportion of Access antibiotics increased substantially, while the use of Reserve antibiotics declined markedly, in accordance with current WHO recommendations for combating antimicrobial resistance. At the same time, the use of broad-spectrum cephalosporins, carbapenems, fluoroquinolones, colistin, and tigecycline decreased, and antibiotic therapy became more targeted and individualised. These findings support the wider implementation of AMS's in inpatient surgical departments. Key factors contributing to the programme's success include multidisciplinary collaboration between surgeons, clinical pharmacists, and infection prevention and control specialists, regular monitoring of antibiotic consumption using DDD per 100 bed-days, and continuous education of healthcare professionals. Together, these measures contribute to improved quality of care and a reduced risk of antimicrobial resistance.

This study has several limitations. It was conducted in a single university hospital surgical department, which may limit the generalisability of the findings to other healthcare settings, particularly hospitals with different patient populations, resource availability, and antimicrobial stewardship models. The retrospective study design, based on the analysis of antibiotic consumption indicators (DDD and DDD per 100 bed-days), does not allow causal relationships to be established between individual AMS interventions and the observed outcomes. Furthermore, the implementation of the AMS coincided with major changes in the hospital's clinical activity, including an increased number of patients with combat-related injuries, expansion of the range of surgical procedures performed, and treatment of more severe infectious complications, all of which may have influenced antibiotic prescribing patterns. In addition, the study did not evaluate clinical outcomes, including the incidence of surgical site infections, in-hospital mortality, length of hospital stay, hospital readmissions, the incidence of *Clostridioides difficile* infection, or changes in antimicrobial resistance patterns among hospital pathogens.

Future research should evaluate the contribution of individual AMS components, including antibiotic pre-authorisation, prospective audit with feedback, local perioperative antibiotic prophylaxis protocols, and educational interventions, to clinical outcomes. Further studies are also warranted to investigate the relationship between changes in antibiotic consumption according to the AWaRe classification and trends in antimicrobial resistance among hospital pathogens, as well as the incidence of surgical site infections, *Clostridioides difficile* infection, length of hospital stay, in-hospital mortality, and pharmacoeconomic outcomes.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Динаміка споживання антимікробних препаратів в стаціонарному хірургічному відділенні при впровадженні програми адміністрування антимікробних препаратів

Анотація
Актуальність. Програми адміністрування антимікробних препаратів (ААП) стали важливою стратегією для оптимізації використання антибіотиків та боротьби з резистентністю до антимікробних лікарських засобів у хірургічній практиці.
Мета. Оцінити вплив впровадження програми ААП на споживання антибіотиків у стаціонарному хірургічному відділенні.
Методи аналізу. Проведено ретроспективний аналіз споживання антимікробних препаратів у 2023-2025 рр. у хірургічному відділенні університетської клініки. Оцінку здійснювали за показниками DDD та DDD/100 ліжко-днів із аналізом структури відповідно до класифікації ВООЗ AWaRe.
Результати. Незважаючи на майже п’ятикратне зростання загального обсягу використаних антибіотиків з 558,1 до 2387,0 DDD через значне збільшення хірургічної допомоги зокрема і постраждалим від бойових поранень, інтенсивність споживання антибіотиків зменшилася з 33,5 до 6,8 DDD/100 ліжко-днів. Частка препаратів групи доступу збільшилась з 5,8 % до 57,3 %, тоді як частка препаратів групи резерву зменшилась з 82,6 % до 4,7 %, що вказує на оптимізацію їх використання. Відмічено суттєве зменшення призначення цефалоспоринів 3 покоління (зокрема цефтриаксону, який згідно галузевому стандарту медичної допомоги віднесено до препаратів групи резерву), і інших препаратів резерву, зокрема – колістину та тайгецикліну. Також зменшилось використання карбапенемів і фторхінолонів, а натомість зросло застосування аміноглікозидів, метронідазолу та кліндаміцину, які відносяться до групи доступу.
Практична цінність. Впровадження комплексної програми ААП забезпечило більш раціональне використання антибіотиків, оптимізацію їх структури відповідно до класифікації AWaRe та зменшення інтенсивності їх споживання, що підтверджує ефективність мультидисциплінарного підходу із залученням клінічного фармацевта у хірургічному стаціонарі.
Ключові слова: антимікробна резистентність; клінічний фармацевт; антибіотики; хірургія; споживання лікарських засобів; визначена добова доза; класифікація AWaRe.