

# Predpisovanje perioperativne antibiotične zaščite v terciarni bolnišnici v Sloveniji - vloga edukacije pri izboljšanju predpisovanja

## Preoperative antibiotic prophylaxis in a single tertiary hospital in Slovenia—the role of education in recommendation compliance

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### Ključne besede:

perioperativna antibiotična zaščita, priporočila, skladnost, kirurgija, izobraževalna intervencija.

### Key words:

perioperative antibiotic prophylaxis, recommendations, compliance, surgery, educational intervention.

### Izvleček

**Namen:** Namen raziskave je bil preučiti vlogo edukacije v izboljšanju predpisovanja perioperativne antibiotične zaščite (PAZ) na treh kirurških oddelkih Univerzitetnega kliničnega centra Maribor pri treh vrstah načrtovanih kirurških posegov (vstavitev totalne kolčne endoproteze-TKE, radikalna odprta prostatektomija-RP in carski rez- CR).

**Metode:** V intervencijski raziskavi smo opazovali vpliv edukacijskega

### Abstract

**Purpose:** The aim of the present study was to evaluate the impact of an educational intervention package on perioperative antimicrobial prophylaxis (PAP) prescription practice in three elective procedures—total hip arthroplasty (THA), caesarean section (CS), and radical prostatectomy (RP)—in a single tertiary care hospital in Slovenia.

**Methods:** An interventional study was performed to evaluate the impact of an

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paketa na izboljšanje predpisovanja PAZ v skladu z lokalnimi priporočili. V predintervencijskem obdobju smo pregledali po 30 popisov treh izbranih vrst elektivnih kirurških posegov. Pri vseh posegih smo pridobili podatke o ustreznosti PAZ (indikacija, izbira, odmerek, in število odmerkov ter čas aplikacije PAZ). Paket izobraževalnih intervencij je vključeval razgovor s predstojniki, izobraževanje zdravnikov na izbranih oddelkih z diskusijo ter priloženimi žepnimi kartončki s priporočili. V postintervencijskem obdobju (3-6 mesecev po intervenciji) smo ponovno pregledali medicinsko dokumentacijo po 30 primerov posegov vseh treh vrst in vnovič analizirali skladnost predpisovanja.

**Rezultati:** Pri izbranih elektivnih posegih (TKE, CR, RP) so v predintervencijskem obdobju predpisovali PAZ povsem skladno s priporočili v 67 %, 70 % in 3.3% pregledanih posegov. Ugotavljali smo odstopanje na področju ustreznega časa aplikacije pred kirurškim posegom in trajanja PAZ. Večje odstopanje od priporočil pri posegu RP je posledica dejstva, da gre za velik poseg v trebušni votlini, kjer se kirurg glede na poseg včasih odloči za podaljšanje PAZ. Po izobraževalni intervenciji se je izboljšala skladnost predpisovanja PAZ s priporočili na vseh treh oddelkih, skladno so predpisovali pri 80%, 90% in 50% primerov pri TKE, CR in RP.

**Zaključek:** Z enostavnim izobraževalnim ukrepom lahko tudi v našem okolju izboljšamo predpisovanje PAZ, kar pomembno vpliva na zmanjšanje porabe protimikrobnih zdravil, posledično se zmanjša vpliv na razvoj protimikrobne odpornosti, znižajo se tudi stroški.

educational intervention package on PAP compliance. PAP prescription practices for three elective types of surgery (THA, CS, and RP) were observed. Thirty operative reports for each type of surgical procedure were evaluated according to indication, timing of preoperative prophylaxis administration, antibiotic selection and dosage, and total prophylaxis duration. This was followed by an educational intervention package that included a discussion with department leaders led by an infectious disease specialist and an educational seminar and discussion for surgeons, supplemented by PAP recommendations provided as pocket reminders. Then, the compliance with PAP recommendations for the same types of procedures performed in the post-interventional period (3–6 months after the intervention) was evaluated again.

**Results:** Complete pre-interventional compliance with local guidelines was observed in 67%, 70%, and 3.3% of THA, CS, and RP cases, respectively. A major deviation from PAP recommendations was observed in the timing of preoperative PAP administration before surgery and in the total PAP duration. A deviation from recommendations for RP, which is a major surgical procedure, was observed as a longer postoperative PAP duration compared to the intraoperative course. In the post-interventional period, an improvement in total compliance with PAP recommendations was observed in 80.0%, 90.0%, and 50.0% of THA, CS, and RP procedures, respectively.

**Conclusion:** Our study revealed an improvement in adherence to PAP recommendations after an educational intervention package for selected procedures at the University Medical Centre Maribor. This simple intervention can have an important impact on patient care quality by reducing antimicrobial medication use, resistance development, and treatment cost.

## INTRODUCTION

Throughout history, the incidence of infections has been an important driver of improvements in medical care. Surgical site infections (SSIs) remain one of the major causes of hospital morbidity and mortality (1). They are one of the most common complications after surgery, which account for approximately 17% of all infections acquired in a hospital setting (HAI). According to Cassini et al., an estimated 3.5 million Europeans are affected by HAIs each year, of which 2.5 million die or suffer from serious complications (2). HAIs affect 501/100,000 patients daily and SSIs are the third most common cause of HAI (2). SSIs have been associated with a longer postoperative recovery time and additional surgery to treat infection complications (2, 3). A British study found that SSIs prolong hospitalization time from 3.3 to 21 days and significantly increase medical treatment cost (4).

Among the important measures for reducing SSIs, appropriate perioperative antibiotic prophylaxis (PAP) can prevent up to 80% of SSIs (5). SSIs most commonly develop due to the introduction of bacteria from the patient's flora or surroundings into the wound area during a surgical procedure (6). In a large-scale study that included 21 meta-analyses of randomized control studies with a total of 48,909 patients, Bowater et al. concluded that regardless of the type of surgery (clean, clean-contaminated, and contaminated), PAP significantly reduced the proportion of all SSIs in a hospital setting (7). Therefore, PAP is recommended only for procedures with a higher risk of postoperative SSI and in procedures with a low risk of infection where infection consequences are likely to be devastating (8). PAP contributes considerably to the total amount of antibiotics used in the hospitals worldwide. It is estimated that 15% of all antibiotics are used for surgical prophylaxis (5,9). Unfortunately, many studies have shown noncompliance with the recommended PAP guidelines in up to 88% of cases, most commonly PAP that was administered for too long (5). A recent study in 14 German hospitals found that PAP was prescribed according to the recommendations in 5–85% of all cases (10). In a large-scale study including 3,253 neurosurgical procedures, Schmitt et al. found that an adequate PAP regimen was prescribed in only

10% of all cases (11). A French hospital reported in 2008 that PAP was adequate in 58% of all observed surgical procedures. Surgeons largely opted for PAP with a correct indication in 85% of cases, chose the correct antibiotic in 82.8% of cases, and administered the antibiotic at the appropriate time prior to surgery in only 40% of cases (12).

Zupan et al. performed an extensive study on compliance with PAP guidelines in Slovenia at the University Clinical Centre Ljubljana. They found total compliance with the recommended PAP in 26% of all cases and the lowest recommendation compliance in the number of PAP doses (46%), which is comparable to other studies across Europe (13).

Optimizing PAP is an important intervention in the antimicrobial stewardship program in hospital settings. The European Centre for Disease Prevention and Control (ECDC) has published key PAP modalities to be implemented to improve PAP compliance (5). Education was found to be an important intervention in improving PAP compliance in different studies (14). Ozgun et al. found that educational intervention improved some aspects of PAP, though it failed to improve the total compliance rate in a Turkish hospital (15). Hulscher et al. discussed the important role of many determinants in hospital antimicrobial agent use in different countries in Europe and North America, as well as the associated cultural, conceptual, and behavioural dimensions (16).

Social, cultural, and organizational factors have a significant impact on the effectiveness of interventions for optimizing antimicrobial use. Consequently, intervention efficacy is not the same across different societies and should be examined in a local environment as well (17).

## METHODS

An interventional study was performed at the tertiary care hospital at the University Medical Centre Maribor. The impact of an educational intervention package on compliance with local PAP recommendations was studied in three different types of elective surgical procedures.

Three surgical departments were included in the study:

Department of Orthopedic Surgery, Department of Urology, and Department of Perinatology. In the pre-interventional period, compliance with the recommended local PAP guidelines was observed in three different types of elective surgery: total hip arthroplasty (THA), radical prostatectomy (RP), and caesarean section (CS). A total of 30 consecutive elective surgical procedures of each type performed before December 31st, 2018 were included in the pre-interventional study. Medical records from patients with preoperative infectious disease, those who received nonprophylactic antibiotics 48 h before the operation, and records from non-elective procedures were excluded.

Medical records for each procedure were reviewed and the following data were obtained: indication, antibiotic selection, antibiotic dosage, preoperative timing of PAP administration, and PAP duration (number of doses). The preoperative PAP timing and dosage information was collected from handwritten anesthesia documentation for every surgical procedure. Prescribed PAP compliance with local recommendations is presented in Table 1.

## INTERVENTION

In March 2019, an educational intervention package was presented to each of the three departments separately. The educational package included first a personal meeting between an infectious disease (ID)

specialist and the department leaders (surgeons) to discuss local PAP guidelines, their PAP administration habits, doubts about PAP recommendations, and possible reasons for noncompliance with PAP guidelines. This was followed by an educational meeting with surgeons at all three departments, which involved an educational program on antimicrobial prophylaxis conducted by the ID specialist, focusing on different aspects of importance of appropriate PAP, continued by a conversation with surgeons about specific problems and possible solutions at their surgical departments. The educational meeting was reinforced by the distribution of pocket PAP recommendations prepared for each department.

The post-interventional period was defined as 3–6 months after the intervention. The medical records of 30 consecutive procedures performed during the post-interventional period were reviewed. The surgeons (except the department leader) were not aware of the post-interventional observations. The same set of PAP data was obtained.

The collected data were analyzed using the statistical software package SPSS version 24 IBM. A descriptive statistical analysis was carried out using chi-square test and Fisher's exact test when appropriate. Differences between groups were significant for variables yielding a p-value of < 0.05.

The study was approved by the Medical Ethics Commission (KME) of University Medical Centre Maribor on March 8, 2019 (letter number: UKC-MB-KME-19/19).

**Table 1.** Local recommendations for perioperative antibiotic prophylaxis at the University Medical Centre Maribor for selected surgery types.

Surgical procedure	First-choice antibiotic	Time of application	Alternative antibiotic	Time of application	Duration
Total hip arthroplasty	cefazolin – 2 g iv 3 g iv – for weight > 120 kg	0–60 min before incision	vancomycin – 1 g iv	60–90 min before incision	up to 24 h (1–3 doses), preferred single-dose regimen
Radical prostatectomy	cefuroxime 1.5 g iv	0–60 min before incision	gentamicin 120 mg iv	0–60 min before incision	single dose
Caesarean section	cefazolin 2 g iv	0–60 min before incision	clindamycin 900 mg iv + gentamicin 120 mg iv	0–60 min before incision	single dose

## RESULTS

The results of pre- and post-interventional compliance rates were expressed as percentage values and presented in Table 2.

In the pre-interventional period, the last 30 elective surgeries of each type performed before 31st December 2019 were included. The post-interventional period was defined as 3–6 months after the intervention. The analysis evaluated 30 consecutive cases of each procedure type performed in the defined time period, although due to their low frequency, only eight RP procedures were included in the post-interventional analysis.

Total pre-interventional compliance rate with local PAP guidelines for THA and CS procedures was observed in 67.0% and 70.0% of cases, respectively, whereas total compliance rate in RP surgery was 3.3%. A major deviation from PAP recommendations was observed in the timing of preoperative PAP administration for THA

and RP procedures and in the number of PAP doses (duration) for the RP procedure, whereas compliance with indication, antibiotic choice, and dosage was satisfactory for all three types of surgeries. RP is a major intraabdominal procedure and prolonged PAP after the procedure is usually associated with the intraoperative course and possible intraoperative complications.

For the THA procedure, all of the patients received PAP within 24 h (as recommended) pre-interventionally and no prolonged PAP was observed. There is still debate about a single-dose PAP vs. PAP administered within 24 h (three doses) for this type of surgery, although recent studies have confirmed that a single dose of PAP prior to the procedure is sufficient for SSI prevention (18, 19). A recommendation for a single dose of PAP was proposed in the department of the educational intervention package. A significant switch to a single-dose PAP was observed in the post-interventional study period, although PAP

**Table 2.** Comparison of PAP<sup>1</sup> prescription compliance among all three studied departments before and after the intervention.

CRITERIA	Surgical procedure			First-choice antibiotic			Time of application		
	BEFORE N (%) (N=30)	AFTERN (%) (N=30)	P*	BEFORE N (%) (N=30)	AFTER N (%) (N=30)	P*	BEFORE N (%) (N=30)	AFTER N (%) (N=8)	P**
Indication	29 (96.7)	29 (96.7)	0.895	29 (96.7)	29 (96.7)	1.00	28 (93.3)	8 (100.0)	1.00
Antibiotic choice	29 (96.7)	26 (86.7)	0.895	26 (86.7)	29 (96.7)	0.785	21 (70.0)	6 (75.0)	1.00
Dosage	29 (96.7)	26 (86.7)	0.327	26 (86.7)	29 (96.7)	0.686	22 (73.3)	6 (75.0)	0.164
Time of preoperative administration	20 (67.0)	24 (80.0)	0.378	24 (80.0)	29 (96.7)	0.579	9 (30.0)	6 (75.0)	.0291
Number of doses (total duration)	3 doses*** 27 (90.0)	3 doses*** 4 (13.3)	0.00001	29 (96.7)	29 (96.7)	0.579	3 (10.0)	7 (87.5)	.0001
	1 dose*** 3 (10.0)	1 dose*** 26 (86.7)							
Total compliance	20 (67.0)	24 (80.0)	0.373	21 (70.0)	27 (90.0)		1 (3.3)	4 (50.0)	0.004

<sup>1</sup> PAP - perioperative antibiotic prophylaxis

\*\* p-value for Fisher's exact test

\* p-value for chi-square test

\*\*\* both single- and three-dose PAP was considered correct in evaluation of compliance with PAP for this type of procedure



administration within 24 h after the procedure was considered appropriate for the study purposes as well.

A trend towards improvement in total post-interventional compliance was observed for the THA and CS procedures and a significant improvement in the RP procedure was present: 67.0%, 70.0%, and 3.3% to 80.0%, 90.0%, and 50.0% for the THA, CS, and RP procedures, respectively. The most significant improvement rate was also observed in the number of PAP doses (single-dose switch) in the THA group post-interventionally.

## DISCUSSIONS

We studied the impact of an educational intervention package on compliance with PAP recommendations in three surgical procedures. Non-compliance with PAP recommendations is a major problem in many countries around the world, including Slovenia (5,13).

Different interventions for optimizing PAP were studied (20-22). Among different factors, cultural norms have an important influence on antimicrobial medication use and PAP compliance (23-25). Ukawa et al. studied the influence of cultural and social norms defined using the Hofstede cultural dimensions on PAP adherence in European countries and found that prolonged PAP positively correlated with power distance and uncertainty avoidance index (23). Borg et al. observed a correlation between prolonged PAP (longer than 24 h) and cultural dimension index in different EU countries (24).

A high-power distance index indicates that people accept a hierarchical order. This may contribute to the antibiotic prescription decisions made by the senior medical staff, which tend to be unchanged by emerging research evidence (25). The present study is the first to investigate the effect of an educational intervention package on prescription of PAP in a tertiary care hospital in Slovenia. According to the Hofstede cultural dimension model, Slovenia is a country with

a high power distance index (score of 71), high uncertainty avoidance index (score of 88), and low individualism index (score of 27) (26). Due to the cultural differences among EU countries, it was assumed that an educational intervention package might not have the same effectiveness as described in some northern EU countries. In a Dutch study by van Kasteren et al., the effect of an educational consultation on compliance with recommended PAP was studied in 13 Dutch hospitals, where PAP compliance increased from 5.4% before the intervention to 63.5% after the intervention (27). Our study revealed some deviations in PAP prescription from the recommended guidelines in all three evaluated procedures, with an overall compliance rate of 67.0%, 70.0%, and 3.3% for THA, CS, and RP procedures, respectively. An overall adherence to the recommendations for PAP was observed (> 93% compliance rate), an appropriate antibiotic was chosen in 70–96% of cases, and the antibiotic dose was appropriate in 73–96.7% of cases. A major deviation from PAP recommendations was observed in the preoperative timing of PAP for all three procedures (appropriate timing was achieved in 67.0%, 80.0%, and 30.0% of procedures, respectively). Results were similar to those from other studies, whereas the study from the University Clinical Center Ljubljana showed a far better compliance (86%) with the recommended timing of PAP administration. As stated by Zupan et al., work organization is the most probable cause of inappropriate PAP timing, which is similar to what was discovered during conversations with surgeons in the present study (13).

A particularly good pre-interventional compliance with the recommended PAP duration was observed in the THA and CS procedures, whereas PAP was prolonged in the RP procedure. However, RP is a major abdominal surgical procedure (with a higher postoperative complication rate) and the three selected procedures cannot be compared directly. The majority of THA patients (90%) received three pre-interventional PAP doses (within 24 h). The international guidelines for this type of procedure are inconsistent for the number of PAP doses

(one vs. three), although new research supports a single-dose PAP for this procedure. A single-dose recommendation was implemented for the THA procedure during the educational seminar in the present study. In the post-interventional period, the proportion of patients receiving a single dose of PAP during the THA procedure increased significantly from 10.0% to 86.7%. The switch to a single dose has a significant impact on reducing antibiotic consumption, consequently reducing side effects and treatment costs. We consider significant progress in switching the number of PAP doses from three to one preoperative dose after an educational intervention as an important indicator of successful intervention.

A significant improvement was also observed in the duration of PAP in the RP procedure, though the sample size was far too small for further conclusions.

The present study revealed an improvement after an educational intervention package in the overall compliance with PAP recommendations for all three types of procedures. According to the ECDC review, it should be the responsibility of an anaesthesiologist to ensure appropriate preoperative timing for PAP (5). Although the present intervention did not include members of the anaesthesiology team, an improvement in appropriate PAP timing was observed in all three procedures, suggesting organizational issues among important factors in PAP improvement. We assume that gaining support for improvement from the department leaders during personal discussions before the intervention was also an important factor for successful intervention.

Pocket cards with PAP guidelines were distributed to surgeons during the educational session as well, which might have had an additional influence on PAP improvement. In a study conducted by Ritchie et al. at two Dutch hospitals, adherence to appropriate PAP procedures improved from 29% before the introduction of the information pocket cards to 74% after the introduction ( $p < 0.001$ ) (28).

## STUDY LIMITATIONS

The present study has several limitations, including small sample size and inclusion of only three surgical departments/procedures in a tertiary care hospital. The educational intervention package was a combination of three separate educational interventions (personal conversation, seminar, and distribution of pocket cards with PAP recommendations), so it is not possible to assess their separate influence on PAP compliance improvement. The effect of education was observed over the course of a relatively short time interval of 3–6 months post-interventionally. Repeated observations over a longer period will provide a more accurate idea of the intervention success. The effect of education might diminish over time and the impact of educational intervention should be reassessed after a longer time period to better plan successful and lasting interventions for the future.

## CONCLUSIONS

We studied the impact of an educational intervention package on compliance with local PAP recommendations in a Slovenian tertiary care hospital. While there are many reasons for noncompliance to PAP guidelines, we found that surgeon education is a reasonable and cost-effective intervention that can lead to improvement in compliance with PAP recommendations and should be implemented as a routine practice.

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