Compliance of antibiotic surgical prophylaxis with the recommendations in the UKC Ljubljana

Alenka Zidar Zupan,[1] Bojana Beović,[2,3] Boštjan Gomišček[4]

[1] Department of Vascular Neurology and Intensive Therapy, Division of Neurology, University Medical Centre Ljubljana, Ljubljana, Slovenia

[2] Department of Infectious Diseases and Febrile Illnesses, University Medical Centre Ljubljana, Ljubljana, Slovenia

[3] Department of Infectious Diseases and Epidemiology, Medical Faculty, University of Ljubljana, Ljubljana, Slovenia

[4] Faculty of Business, University of Wollongong in Dubai, Dubai, United Arab Emirates

Correspondence:
Alenka Zidar Zupan,
e: alenkazup@gmail.com

Key words:
quality in health care; safety culture; guidelines; surgical infection; antibiotic surgical prophylaxis

Received: 2. 11. 2016
Accepted: 9. 1. 2018

Abstract

Background: The antibiotic surgical prophylaxis (ASP) is very important as it can decrease the incidence of surgical infections. However, selection pressure of antibiotics is an important driver of antimicrobial resistance and may stimulate development of post-operative infections with resistant bacteria. This study aims to explore the level of compliance of ASP in daily practice with the set guidelines.

Methods: Consecutive patients treated in the years 2011 and 2012 in UKCL were included in this retrospective study. Their medical records were reviewed and the results compared against the US Guidelines published in 2013. The following parameters were included in the study: application of an antibiotic prior to surgery, the appropriateness of the antibiotic and its dosage, application time and the number of doses applied.

Results: Altogether 451 surgical procedures from 8 different UKCL's surgical units were analyzed. Patients age ranged from 18 to 97 years. Total compliance with the recommendations of ASP was achieved in 26 % of the cases. Antibiotic prophylaxis was applied in 87 % (range 62–100 %) of procedures with the indicated ASP. Appropriate choice of antibiotic reached 95 % (range 46–100 %). The lowest score was observed for the number of doses applied; the average compliance across 8 units was 46 %. Overall, the ASP was compliant with guidelines in 26 %.

Conclusion: The study revealed that there is much space for improvement regarding the studied parameters of the ASP, in particular with regard to the appropriate number of doses of antibiotics administered. The prescribing and administrating of ASP in accordance with the recommendations depend strongly on the awareness and education of health care personnel as well as on supervision, feedback and supportive and blameless organization with good interpersonal communication.

Cite as: Zidar Zupan A, Beović B, Gomišček B. [Compliance of antibiotic surgical prophylaxis with the recommendations in the UKC Ljubljana]. Zdrav Vestn. 2018;87(3–4):105–13.

DOI: 10.6016/ZdravVestn.2361

1. Introduction

Health care will never be completely free of risks for the patient and the health professional. We must bear in mind, however, that many hazardous events, usually resulting from process or system errors, are preventable.[1] Control of

hospital-acquired infections is a major challenge in the field of safe and quality hospital care. Infections lead to prolongation of treatment and hospital stay, they increase the number of diagnostic and therapeutic procedures; all this is related to higher treatment costs and lower quality level of services rendered. Thus, from a professional and economic point of view, prevention of hospital infections is more important than their treatment.[2]

An estimated 234 million surgical procedures are performed annually around the world. More than a million patients die of complications during the procedure. Surgical complications can be efficiently prevented.[3] According to data of the US Center for Disease Control and Prevention (CDC), surgical wound infections are an important health problem all over the world. They prolong the duration of treatment and hospital stay, and increase mortality and treatment costs.[4] A cross-sectional study of the European Centre for Disease Prevention and Control (ECDC), conducted in the years 2011 and 2012 in several European Countries including Slovenia, showed surgical wound infections, with an incidence of 20 %, to be second in incidence among all hospital infections, immediately after respiratory tract infections with 24 %. The incidence of surgical wound infections was found to range from 9 % in Luxembourg to 29 % in Spain.[5] According to the findings of the Institute for Healthcare Improvement, prophylactic use of antibiotics can prevent between 40 % and 60 % of infections during and after surgical procedures. The value of ASP in the prevention of infections is undisputable; its omission is considered a medical error.[4]

According to a recently published report of the British government, the development of antimicrobial resistance will soon lead to dangerous health and macroeconomic consequences, especially in developing counties. From the year 2000 to 2010, the consumption of antibiotics increased by 40 %. Given the current trends, 390,000 people will die annually in Europe by the year 2050 because of antimicrobial resistance. Appropriate ASP has a significant role in preventing the development of antimicrobial resistance.[6] In the University Medical Centre Ljubljana (UKCL), the Antibiotics Commission in 2006 issued a manual for the use of antimicrobial agents, which also includes recommendations for ASP.[7] The Society for Antimicrobial Treatment of the Slovenian Medical Association issued similar recommendations in 2013.[8]

The aim of our study was to determine the consistency of using ASP in UKCL and its compliance with the existing recommendations.

2. Methodology

A retrospective study on the use of ASP was carried out in UKCL. The Slovenian recommendations for antibiotic treatment issued by UKCL in 2006[7] and the US guidelines published in 2013[9] were employed. The study was restricted to surgical units, where the medical records for 1 to 3 different surgical procedures performed in the years 2011 and 2012 were reviewed. Up to 30 cases were reviewed for each procedure. For procedures performed infrequently, the records for all available cases were gathered. Cases where the patient was given an antibiotic for the treatment of an infection were excluded from the study. The following data were recorded: application of ASP, antibiotic prescribed, its dosage, time of application with respect to the start of the procedure, and number of doses administered. The data obtained were compared against

the recommendations in Table 1, which agree with the US guidelines published in 2013.[9]

Compliance of ASP application was analysed for all patients included in the study. Compliance of type of antibiotic, dosage, time and number of doses was analysed only for patients given an antibiotic. For all antibiotics except vancomycin, administration within 60 minutes before surgical incision was considered appropriate application time. Use of vancomycin is recommended for patients infected or colonized with MRSA; there were no such patients in our study. For procedures lasting longer than two half-lives of the antibiotic used, we checked if an additional dose had been administered. For cefazolin, re-application after three hours was considered appropriate.[10] Ethical compliance of the study was approved by the Medical Ethics Committee of the Republic of Slovenia on 1 June 2016 (Decision No. 0120–324/2016–2, KME 90/06/16).

Table 1: Recommendations for antibiotic surgical prophylaxis used in the study. (9).

Procedure	First-choice antibiotic	Time of application	Alternative agents	Time of application	Duration of treatment
Colon cancer surgery	gentamicin 120 mg iv and metronidazole 500 mg iv	0–60 min before surgery	cefazolin 2 g iv and clindamycin 600 mg iv	0–60 min before surgery	1 dose
Pancreatic cancer surgery	cefazolin 2 g iv and metronidazole 500 mg iv	0–60 min before surgery	gentamicin 120 mg iv and clindamycin 600 mg iv	0–60 min before surgery	1 dose
Hysterectomy	cefazolin 2 g iv	0–60 min before surgery	clindamycin 600 mg and gentamicin 120 mg iv	0–60 min before surgery	1 dose
Brain tumour surgery	cefazolin 2 g iv	0–60 min before surgery	vancomycin 1 g iv	60–90 min before surgery	1 dose
Subdural haematoma surgery	cefazolin 2 g iv	0–60 min before surgery	vancomycin 1 g iv	60–90 min before surgery	1 dose
Herniated disc surgery	cefazolin 2 g iv	0–60 min before surgery	vancomycin 1 g iv	60–90 min before surgery	1 dose
Rhizarthrosis, joint reconstruction	cefazolin 2 g iv	0–60 min before surgery	vancomycin 1 g iv	60–90 min before surgery	1 dose
Mastectomy and mammoplasty	cefazolin 2 g iv	0–60 min before surgery	vancomycin 1 g iv	60–90 min before surgery	1 dose
Lung cancer surgery	cefazolin 2 g iv	0–60 min before surgery	vancomycin 1 g iv	60–90 min before surgery	1 dose
Oesophageal cancer surgery	cefazolin 2 g iv	0–60 min before surgery	vancomycin 1 g iv	60–90 min before surgery	1 dose
Prosthetic joint replacement	cefazolin 2 g iv/8 h	0–60 min before surgery	vancomycin 1 g iv/12 h	60–90 min before surgery	up to 24 hours
Humerus fracture management	cefazolin 2 g iv	0–60 min before surgery	vancomycin 1 g iv	60–90 min before surgery	1 dose
Osteosynthesis of femur	cefazolin 2 g iv	0–60 min before surgery	vancomycin 1 g iv	60–90 min before surgery	1 dose

3. Results

In Table 2, analysis of compliance with the guidelines is presented for all surgical units included in the study and for a total of 14 different procedures. The results are expressed as percentage values. Two of the procedures were performed in two different units.

The analysis revealed that some surgical procedures were prolonged. In Unit E, the operation for procedure E3 mostly lasted more than 200 minutes. When the duration of the procedure exceeds two half-lives of the antibiotic used (cefazolin), it is advisable to administer an additional dose. This was done in 8 out of 35 patients.

4. Discussion

The study showed that in the units of different surgical specialties included in our analysis, ASP fully complied with the guidelines on average for only 26 % of the procedures. The highest compliance rate was found for choice of antibiotic (95 %) and the lowest for duration of ASP or number of doses given (46 %).

Already in 1980, Wilson and co-workers carried out a study in Scotland, based on a questionnaire, which was sent to surgeons of different specialties. 21 %

Table 2: Proportion of compliant results for ASP in different units and for individual surgical procedures.

Sur-gical unit	Pro-cedure	Anti-biotic applied (%)	Appro-priate antibiotic (%)	Appro-priate dose (%)	Appro-priate timing (%)	Appro-priate number of doses (%)	Proportion of patients who achieved 100 % compliance (%)
A	A1	78	100	88	85	25	16
B	B1 = A1	100	100	100	93	0	0
	B2	96	74	63	100	19	4
C	C1	62	46	46	33	46	5
D	D1	92	100	100	75	88	43
	D2	72	100	100	100	93	65
	D3	80	100	100	96	95	43
E	E1	86	100	96	81	33	24
	E2	86	100	100	96	17	14
	E3	97	100	100	97	0	0
F	F1	90	100	100	67	10	10
	F2	90	100	100	81	65	11
G	G1	90	100	100	100	30	17
H	H1	89	100	100	88	83	68
	H2	85	100	100	81	96	70
	H3 = G1	96	100	100	96	33	19
Average total		**87**	**95**	**93**	**86**	**46**	**26**

of the surgeons reported using ASP in gallbladder surgery, 49 % in pancreatic surgery, and 95 % in elective procedures on the colon. The surgeons who were not administering ASP gave the following reasons for its omission: very low incidence of wound infection in their surgical practice (2 thirds of respondents), insufficient evidence for efficacy of ASP (24 %), potential to cause bacterial resistance (21 %), increase in costs of treatment when ASP is prescribed (15 %), and drug toxicity (8 %); 23 % reported using ASP only in specific cases.[11]

Malavaud and co-workers studied compliance with ASP guidelines in a hospital in Toulouse, France. The study showed that ASP was prescribed for 85 % of those procedures for which it was indicated.[12] A study conducted by Al-Momany and co-workers in King Hussein Medical Centre in Jordan showed that ASP was administered for all surgical procedures in the cardiology unit.[13] A similarly satisfactory compliance rate were reported by McHugh, in whose study ASP was applied in 95 %.[3]

With regard to the choice of antibiotic and appropriate dosage, several studies in other countries have shown worse results compared to ours, which are noncompliant in less than 7 %. The most frequently prescribed and recommended antibiotic was cefazolin, which has a comparatively narrow spectrum and is comparatively inexpensive. Gindre and co-workers conducted a study in Saint-Roch Hospital, which showed that an unsuitable antibiotic was selected in 25 % of cases.[14] Another study performed by Van Disseldorp and co-workers in 2006 showed that an unsuitable antibiotic was selected in 69 % of cases, and the dosage did not comply with the guidelines in 20 % of cases.[15]

The time of application is variously defined in different professional sources. Some recommend application 0 to 60 minutes before surgical incision, while others consider application 30 to 60 minutes before incision to be more effective in preventing surgical infection. According to the Slovenian guidelines, an antibiotic should be given 0 to 60 minutes before incision, and this was taken into account in our study. An exception is vancomycin, which requires longer administration and must therefore be started 60 to 90 minutes prior to incision. In UKCL, the recommended application time was observed in 86 % of cases. The reason for this less than satisfactory result may probably be attributed to organization of work and inadequate coordination between the surgical and anaesthetic teams. In most cases of non-compliance, the antibiotic was given too soon; in 11 cases it was given too late, thus only during the procedure. Comparison of the results in UKCL with international studies suggests that compliance of the timing of antibiotic administration in UKCL is rather high compared to other hospitals in the world. The study conducted by Gindre and co-workers in Saint-Roche Hospital found that antibiotics were given at an inappropriate time in 31 % of cases.[14] The study conducted by Van Disseldorp and co-workers in Nicaraguan hospitals in 2006 showed that the antibiotic was given at an unsuitable time in 78 % of cases: in 63 % it was given after surgical incision and in 15 % more than 90 minutes before incision.[15] Malavaud and co-workers, investigating ASP for gastrointestinal surgical procedures, found that the timing of antibiotic administration was appropriate in only 39 % of cases.[12] Al-Momany and co-workers found 99 % compliance with the guidelines in King Hussein Medical Centre. They also noted that 97 % of patients were given an antibiotic the night before surgery, which was not in accor-

dance with the guidelines.[13] Alexiou and co-workers performed an international survey among surgeons, in which they inquired about the timing of ASP. On the basis of 1068 completed questionnaires, they found that 26 % of the surgeons did not administer an antibiotic within 60 minutes prior to surgical incision. The study also revealed a significant difference between Europe and the USA: whereas in Europe antibiotics were given at the time of surgical incision by 19 % of surgeons, such practice was less common in the USA (4 %).[16] In the study conducted by McHugh and co-workers, ASP timing was inappropriate in 41 % of cases.[3]

The number of doses should be increased to 24 hours only for procedure G1/H3 (the same operation performed in two surgical departments). All other procedures require only a preoperative dose, which is repeated if the procedure is prolonged. Average compliance for the number of doses in UKCL was only 46 %. Difficulties with the number of antibiotic doses are apparent also from studies by other authors. In 2002 Gindre and co-workers found that antibiotics were administered longer than necessary in 19 % of cases.[14] Al-Momany and co-workers observed that 39 % of patients undergoing heart surgery received antibiotics in accordance with the guidelines (for up to 48 hours after the procedure), while 59 % were administered antibiotics for more than 48 hours. In longer procedures, a second dose was never given.[13] Out of 1068 surgeons participating in the survey conducted by Alexiou and co-workers, 27 % reported continuing antibiotic prophylaxis for two or more days after the procedure, which was not in accordance with the ASP guidelines. In Europe an antibiotic was prescribed for more than 24 hours after the procedure by 26 % of surgeons and in the USA by 14 %.[16] In a cross-sectional study conducted by ECDC, antibiotics were prescribed for more than a day in 59 % of cases, for a day (24 hours) in 16 %, and for less than 24 hours (single dose) in 25 %.[5]

Based on our literature survey, we may conclude that the data for UKCL are comparable to most studies reviewed. The relatively poor compliance observed in our study suggests that there is much space for improvement.

Our study has several shortcomings. Since it was retrospective, we were able to include only data that were unequivocally accessible in medical records. Another shortcoming is the smallness of the sample in individual hospital units.

5. Measures for improvement

For improvement of compliance with the guidelines, education in the field of surgical site infections should be enhanced. The costs of educational measures are well below those incurred by the treatment of infections and their consequences.[17]

O'Reilly and co-workers have demonstrated that the timing of antibiotic prophylaxis can be improved by providing feedback to the anaesthetic team via e-mail. They managed to increase compliance from 69 % to as high as 92 %.[18]

Compliance could be improved also by periodic internal audits. The Ministry of Health of the Republic of Slovenia, in the Handbook of Health Care Quality Indicators, recommends collecting data continuously over at least two periods each year. The data should be collected prospectively since this offers more opportunities for achieving a positive effect on quality, reduces the burden of data collecting, and restricts the number of incomplete files.[19] In order to avoid duplication of records, all acquired data

could be entered into an information system with a visual-electronic reminder for missing information. This would facilitate data transfer and assist in organizing and tracing the process and measurement of outcomes.

In addition to internal audits, we recommend annual external audits; these could be conducted by the hospital's infection prevention and control service, which would present its observations to the surgical team or an individual health professional, chief of unit and head of department, calling their attention to possible deviations.

At the Royal College of Surgeons in Ireland, surgeons have access to a website, SurgInfection, for assistance in selecting an antibiotic for individual procedures. The website is very simple to use; when the name of a surgical procedure has been entered, information on the appropriate antibiotic, its dosage and number of doses is displayed. The introduction of such an online tool or link to the SurgInfection website would facilitate the work of health professionals and improve patient safety.

As an ASP reminder for certain surgical procedures, we suggest using a poster located in a conspicuous spot, which would alert health professionals to the importance and proper timing of antibiotic prophylaxis. Clearly visible on the poster should be the phone number of an infectologist responsible for the field of ASP, who may be consulted when necessary.

We also recommend maintaining an accurate schedule of surgical procedures, which would allow better timing of ASP; because of occasional delays in the work of the surgical and anaesthetic teams, the time of administration of an antibiotic by the anaesthetist may not be coordinated with the time of incision performed by the surgeon.

In order to improve compliance with the ASP guidelines in an Argentinian hospital, Gomez and co-workers have introduced a form in which the following information is recorded: patient's name and number, date and time of procedure, type of wound, surgeon's name and recommended ASP. After each surgical procedure, the completed form is sent to the pharmacy, where it is reviewed by the pharmacist and the prescribed medication is issued. If the attending physician feels that ASP should be prolonged, the pharmacist is requested to supply additional doses. The results of the study show that with the use of this form, unnecessary prolongation of antibiotic prophylaxis has been reduced.[20]

We recommend that a similar form with included instructions be made available to our surgeons online (as part of the hospital information system) and attached to the patient's record prior to the procedure. The surgeon could propose a prolongation of antibiotic treatment when necessary. The (printed) form would be sent to the pharmacy.

We further suggest that any existing instructions for ASP that are already in use in individual surgical units be reviewed and updated as required.

6. Conclusion

The study aimed to identify inconsistencies in the use of ASP, so that individual surgical units could be informed of the area that needs to be brought in conformity with the guidelines in order to improve the management and ensure greater safety of their patients. The often appropriate choice of an antibiotic and its dosage suggests that doctors are adequately informed about ASP and follow the recommendations. There were some more discrepancies in the timing of administration; before some procedu-

res, the antibiotic was given too early or too late.

The lowest compliance was observed for the number of antibiotic doses prescribed, which was often greater than recommended. We have given some suggestions for improving the system of patient care before and during a surgical procedure with regard to providing appropriate ASP.

By presenting our results, we wish to encourage other surgical departments in Slovenia to review the status of ASP and possibly adopt the necessary measures to improve this important method of preventing surgical infections.

Acknowledgement

The authors are grateful to the surgical departments and units of UKCL for cooperation and support in carrying out the study.

We also thank Zdenko Garašević for assistance with statistical analysis of the data.

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