Susceptibility of perioperatively isolated bacteria to cefazolin – A pilot study

Občutljivost perioperativno osamljenih bakterij za cefazolin – pilotna raziskava

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Abstract

Introduction: The selection of perioperative prophylactic antibiotic is based on the expected bacterial flora in the site of the surgical procedure and its susceptibility to antibiotics. Recent reports on coagulase-negative staphylococci, typical representatives of skin flora, showed their resistance to methicillin. We may wonder whether cefazolin is still the antibiotic of choice for surgical prophylaxis in clean surgical procedures.

Patients and methods: In a prospective study we included patients who underwent surgical treatment for various types of injuries. Three swab samples were taken in each patient.

The first sample was taken from the incision site before the operating field was prepared. The second swab was taken after the operating field preparation and the third was taken at the end of the operation. The results of microbial growth and the susceptibility to antibiotics were recorded. The incidence of a wound infection in patients included in the study was followed prospectively. In the case of infection, the bacteria isolated intraoperatively during the surgical revision were compared to the bacteria isolated perioperatively at the time of the first surgery. All patients received cefazolin in a single dose of 1 to 2 grams according to their weight pre-operatively. The antibiotic was administered 20 minutes before the incision. No additional antibiotic dose was given after surgery.

Results: Before the operating field was prepared, swabs were sterile in two patients (6.4 %), at the end of preparation the swabs remained sterile in 22 (71 %) patients and at the end of surgery in 13 (42 %) out of the 31 injured patients. There were no methicillin-resistant swab cultures after operative field preparation, but at the end of surgery in four patients (13 %) the swab cultures grew methicillin resistant Staphylococcus epidemidis. Bacillus sp. was isolated in five patients (16.1 %) after operative field preparation and in two patients (6.4 %) at the end of surgery. The susceptibility of the Bacillus sp. was not determined because of the lack of standardized testing method.

Conclusion: In a pilot study we found a large proportion (4/31) of patients in whom colonization of the operative field with cefazolin-resistant bacteria developed during the surgical procedure. The result of our pilot study challenges the guidelines recommending cefazolin for surgical prophylaxis in clean surgery. Further studies in larger patient population are needed.

Izvleček

Uvod: Izbira antibiotikov za antibiotično kirurško profilakso temelji na pričakovani bakterijski flori v območju kirurške rane in njihovi dovzetnosti za okužbe. Poročila o koagulazno negativnih stafilokokih, značilnih predstavnikih kožne flore, govorijo o njihovi pogosti odpornosti proti meticilinu. Lahko se vprašamo, ali je cefazolin še antibiotik izbire pri preprečevanju kirurških okužb.

Bolniki in metode: V prospektivni raziskavi smo operiranim po različnih poškodbah odvzeli tri kožne brise. Prvi bris smo odvzeli na mestu kožnega reza pred pripravo operacijskega polja, drugo kužnino po pripravi in tretjo ob koncu operacije. Spremljali smo rezultate odvzema kužnin in občutljivost osamljenih bakterij za različne antibiotike. Hkrati smo spremljali pojavnost okužb. Bakterije, osamljene ob okužbah, smo primerjali z bakterijami, odvzetimi ob prvi operaciji.

Bolniki so 20 minut pred kirurškim rezom prejeli 1 do 2 grama cefazolina, odvisno od telesne teže. Bolniki niso prejeli dodatnih odmerkov antibiotika.

Rezultati: Pred pripravo je bilo operacijsko polje sterilno pri dveh bolnikih (6,4 %), po pripravi pri 22 bolnikih (71 %) in ob koncu operacije pri 13 bolnikih (42 %). Po pripravi operacijskega polja nismo osamili bakterij, odpornih proti meticilinu, ob koncu operacije pa smo osamili pri štirih bolnikih (13 %) bakterije, odporne na meticilin. Pri 5 bolnikih (16,1 %) smo po pripravi operativnega polja, pri dveh (6,4 %) pa ob koncu operacije, osamili Bacillus sp., za katerega pa metoda za določanje občutljivosti antibiotikov ni standardizirana.

Zaključek: Pri bolnikih smo ob operaciji ugotovili pogosto kolonizacijo z bakterijami, ki so odporne proti meticilinu (4/31, 13 %), zato je izbira cefazolina za profilakso ob kirurškem posegu vprašljiva. Za potrditev rezultatov pilotne raziskave bi bilo treba raziskavo razširiti.

Introduction

Surgical site infections (hereinafter SSI) represent one of the most common surgical complications.[1] The incidence rate is estimated between 5 % and 30 %.[2] Patients with such a complication have longer duration of hospital stay and/or in intensive care unit, are more frequently re-admitted and have a higher mortality rate.[3] In the USA for example, it is estimated that in 20 million operations a SSI is present in 2 million cases. [3] In the USA, it is estimated that in 20 million operations a SSI is present in 2 million cases.[4] The most common microorganisms responsible for a SSI in trauma surgery are Staphylococcus aureus (35.5 %), followed by coagulase-negative staphylococci (12.9 %).[5,6] Accordingly, in the case of a closed fracture, knee or hip arthroplastic surgery a prophylactic use of anti – staphylococcal antibiotics such as cefuroxime or cefazoline is recommended.[7]

Patients and methods

The protocol for this study was approved by the National Medical Ethics Committee of Slovenia (17. 7. 2012). Written informed consent was obtained from all patients before their inclusion in the study.

In 31 patients, who were operated on because of different types of injuries, three swab samples were taken. The first sample was taken from the incision site before the operating field was prepared. The second swab was taken after the operating field preparation, just before the incision, and the third sample was taken from the operating wound at the end of the operation. All patients received cefazolin in a single dose of 1 to 2 grams according to their weight pre-operatively. The antibiotic was administered 20 minutes before the incision. No additional antibiotic dose was given after surgery. The preparation of the operating field and the swab sample collection was conducted by the same surgeon, in exactly the same way. The swab samples were taken according to the protocol written in the recommendations.[8] The operating field was washed and softened with three tampons soaked in 0.1 % chlorhexidine solution, then wiped with two fresh dry tampons, and at the end disinfected with alcohol tincture (Dodesept®). For protection, iodine protection folio-loban TM 2® was used during surgery.

Patients were followed for a period of one month; if signs of an infection appeared, relevant samples were taken for microbiological testing.

Results

Patients' demographics, diagnoses, types and duration of surgical procedures, blood loss, antibiotic doses, type of surgery such as urgent or elective, and preoperative ASA[9] score, are presented in Table 1.

Isolated bacteria according to the phase of operation are shown in Table 2.

Before the operating field was prepared the swabs were sterile in two (6.4 %) patients, at the end of preparation the swabs remained sterile in 22 (71 %), and at the end of operation in 13 (42 %) out of the 31 injured patients. There were no methicillin-resistant swab cultures after operative field preparation, but at the end of surgery in four patients (13 %) the swab cultures grew methicillin resistant Staphylococcus epidemidis (Table 3). Bacillus sp. was isolated in five patients

Table 1: Demographics of the study population, procedures, ASA score, AMD dose of cephazolin.

Case num.	Age (years)	Gender	Diagnosis	Op procedure	Op duration (min.)	Asa	Blood loss (ml)	Operation (elective, urgent)	Dose of cefazolin (gram)
1	63	W	FRACT.TIBIAE	OS with plates	120	1	<500	Elective	2
2	40	M	PSEUDOARTHR FEM	OS with nail	120	1	<500	Elective	2
3	48	W	FRACT.COLLI FEM.	PEP	70	2	<500	Elective	1
4	54	M	AC ARTHROSIS	Acromioplasty	60	1	<100	Elective	1
5	44	M	FRACT.CALCANEI	OS ATC	90	2	<100	Elective	2
6	38	M	FRACT.RADII	OS with plate	90	1	<100	Elective	2
7	86	W	FRACT COLLI FEM.	PEP	80	3	<500	Elective	2
8	69	W	FRACT.CAPITULI	Extripatio fragmentii	60	1	<100	Elective	2
9	50	W	FRACT. ATC	OS ATC	60	2	<100	Urg	2
10	30	M	FRACT.CLAVICULAE	OS with plate	60	1	<100	Elective	2
11	82	M	FRACT.PERTROCH.FEM.	PFNa	60	2	<500	Elective	1
12	63	M	FRACT PERIPROTHESIS	Cerclage	60	2	<500	Elective	2
13	24	M	AC SINDESMOLYSIS	OS with plates	30	1	<100	Elective	2
14	46	M	FRACT.CAPITULI	Extripatio fragmentii	30	1	<100	Elective	1
15	72	W	PSEUDOARTHR RADII	OS with plate	120	2	<500	Elective	2
16	87	W	FRACT.PERTROCH.FEM.	PFNa	60	2	<500	Elective	1
17	31	M	FRACT.TIBIAE	OS with plates	90	1	<500	Elective	2
18	14	M	FRACT.ANTEBRACHII	OS with plates	60	2	<100	Elective	1
19	83	W	FRACT COLLI FEM.	PEP	90	2	<1000	Elective	2
20	58	M	FRACT ULNAE	OS with plate	60	1	<100	Elective	2
21	64	M	FRACT.PERTROCH.FEM.	PFNa	80	2	<1000	Elective	2
22	77	W	FRACT.PERTROCH.FEM.	PFNa	60	3	<500	Elective	1
23	63	W	PSEUDOARTHR DIGITI	OS with plate	60	1	<100	Elective	1
24	79	M	FRACT.FEMORIS DIST.	DCS	120	3	<1000	Elective	2
25	74	W	FRACT.PERTROCH.FEM.	PFNa	60	3	<500	Elective	1
26	54	M	FRACT FEM DIST.	OS with screws	100	2	<500	Elective	2
27	80	M	FRACT.PERTROCH.FEM.	PFNa	60	2	<500	Elective	2
28	49	M	FRACT.CLAVICULAE	OS with plate	60	1	<100	Elective	2
29	84	W	FRACT.PERTROCH.FEM.	PFNa	60	3	<500	Elective	2
30	78	W	FRACT.COLLI FEM.	PEP	90	2	<1000	Elective	2
31	16	M	FRACT.CLAVICULAE	OS with plate	60	1	<100	Elective	1

Notes:
PEP..PARTIAL HIP ENDOPROSTHISIS
PFNA..PROXIMAL FEMURAL NAIL
AC.ACROMIOCLAVICULAR

(16.1 %) after operative field preparation and in two patients (6.4 %) at the end of operation . The susceptibility of the Bacillus sp. isolates was not determined because of the lack of a standardized testing method. Diagnoses for patients with methicillin-resistant swab cultures were: fracture tibiae proximalis, radii, claviculae and periprosthetic fracture of the femur.

In one of the patients, a superficial infection of the surgical wound appeared within one month postoperatively. The wound swab revealed isolate of the same species (S. aureus) and with the same antibiotic susceptibility (susceptible to all tested antibiotics) as the isolate from the sample taken before the operating field preparation in the same patient, while the swabs taken after the field preparation and at the end of operation in the same patient remained sterile. Further identification of the isolate was not performed.

Discusion

The aim of our study was to determine the skin colonizing flora in the patients who underwent surgical procedures and received cefazolin as antibiotic surgical prophylaxis. In addition, we were interested in the susceptibility of the flora to cefazolin, one of the antibiotics that are commonly used for surgical prophylaxis. Swab samples were taken from 31 trauma patients who underwent

Table 2: Isolated bacteria according to the phase of operation.

	Before operating field preparation (%)	After operating field preparation (%)	At the end of the operation (%)
STERILE	2 (6.4)	22 (71)	13 (42)
S. epidermidis (MS)	8 (25.8)	2 (6.4)	8 (25.8)
S. epidermidis (MR)	1 (3.2)	0 (0)	4 (12.8)
Bacillus sp.	4 (12.8)	5 (16.1)	2 (6.4)
S. aureus	6 (19.3)	0 (0)	2 (6.4)
S. hominis (MS)	5 (16.1)	0 (0)	0 (0)
S. hominis (MR)	2 (6.4)	0(0)	0 (0)
S.. haemolit. (MS)	4 (12.8)	0 (0)	0 (0)
S. haemolit.(MR)	1 (3.2)	0 (0)	0 (0)
Propionibact. acnes	0 (0)	0 (0)	1 (3.2)
Enteroc. faecalis1	2 (6.4)	0 (0)	0 (0)
S. capitis	2 (6.4)	0 (0)	2 (6.4)
Strept. viridans	1 (3.2)	0 (0)	0 (0)
Clostr. perfrigens	0 (0)	1 (3.2)	0 (0)
S. warneri (MS)	0 (0)	1 (3.2)	0 (0)
S. scleiferii	1 (3.2)	0 (0)	0 (0)
Aerococcus viridans	1 (3.2)	0 (0)	0 (0)
Dermabacter hominis (MS)	0 (0)	0 (0)	1 (3.2)
Enterococcus gallinarum	1 (3.2)	0 (0)	0 (0)
Bacillus licheniformis	0 (0)	1 (3.2)	0 (0)
Difteroidi	1 (3.2)	0 (0)	0 (0)
E. coli	1 (3.2)	0 (0)	0 (0)

surgery. The skin swabs were taken before and after operating field preparation and at the end of the operation, after wound closure.

SSI may occur because of contamination of the surgical incision during surgery.[10] Aerobic Gram-positive cocci are most common microorganisms responsible for a SSI.[11,12]

The preparation of the operating field is a very important step in SSI prevention.[5] The operating field is prepared with a combination of chlorhexidine and alcohol, which is recommended by several authors.[13,14] as the most effective method for operating field preparation. In our study, the operating field remained sterile after field preparation in 71 % of the patients who underwent surgery. With only 71 % sterility before surgery we can prove that our procedures of operating field preparation are insufficient. In addition, only 42 % of the patients had sterile operating fields at the end of surgery. Recolonization can be interperated as a transition from the operating material or from the operating staff, either way this represents a serious concern, which requiers a more detailed analysis and action. In the study conducted by Savages and colleagues,[14] at the end of surgery a rise of positive cultures from 3 to 33 percents was observed.

The basic principle of the antibiotic surgical prophylaxis is the concentration of antibiotic above the minimal inhibitory concentration at the time of wound contamination.[15] Following this principle, it is obvious that the use of an antibiotic after the wound closure does not add to the prevention of SSI. In this way a preventive single dose concept was established.[15,16] No additional antibiotic dose was given after surgery in our study.

We found that a substantial proportion (13 %) of patients had a methicillin-resistant bacteria at the end of surgery.

In a retrospective cohort study, Peel with colleagues[17] investigated the incidence rate of infections after artificial arthroplastic implant surgery. In almost 63 % of the cases, the bacteria found were resistant to cefazoline, which was used as a preventive antibiotic. They reported that vancomycin was used as a preventive antibiotic only in the case of known MRSA colonization in patients at high risk for MRSA colonization, and in the case of known allergies for beta-lactam antibiotics. In their study, MRSA was isolated as responsible for the infection in 45 % of the cases.

Osei with colleagues[18] looked for an answer to the question, which antibiotic can be used for prophylaxis when there is a known allergy to penicillin. In the case of an allergy, the use of vancomycin or clindamycin is recommended.[19] From this, they concluded that in the case when cephalosporins cannot be used, vancomycin becomes the gold standard. The use of vancomycin is potentially toxic; it can cause ototoxicity, thrombocytopenia, superinfection, and the most common side effect known as "the red man syndrome". The red man syndrome is characterized by flushing and/or an erythematous rash that affects the face, neck, and upper torso. Symptoms may be treated or prevented with antihistamines, and are less likely to occur with slow infusion. For now, no vancomycin-resistant MRSA was isolated at the Institute of Public Health Maribor (ZZV Maribor).

The most common adverse events associated with clindamycin are gastrointestinal disorders and allergy; diarrhea has been reported in up to 20 % of patients. Clindamycin administration has also been associated with the development of Clostridium difficile colitis, which may be fatal.

Table 3: The antibiotic susceptibility of bacteria, isolated at the end of operation, resistant to cefazolin.

Antibiotic	N susceptible/ N of isolates
oxacilin	0/4
gentamicin	2/4
ciprofloxacin	3/4
erythromycin	0/4
chloramphenicol	4/4
tetracycline	3/4
trimetophrin-sulphamethoxasole	4/4
clindamycin	2/4

Our study showed that a substantial proportion of patients undergoing clean surgery are colonized with methicillin-resistant bacteria in which cefazolin is not the drug of choice for wound infection prevention. Since this is a pilot study with only few patients included, further expansion of the study is needed to yield significant conclusions.

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