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Spectrum of pathogens in surgical site infections at a Swiss university hospital

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Summary

BACKGROUND: The type of surgical antimicrobial prophylaxis (SAP) is determined by the spectrum and antimicrobial resistance of pathogens causing surgical site infections (SSI). The aim of this study was to define the microbiological features of SSI in general surgery patients at Basel University Hospital in order to validate our current strategy of single-shot SAP with 1.5 g cefuroxime (plus 500 mg metronidazole in colorectal surgery).

METHODS: A prospective observational cohort of consecutive vascular, visceral and trauma procedures was analysed to evaluate the incidence of SSI. Surgical wounds and resulting infections were assessed to centres for disease control standards. Microbiological evaluation was performed by microscopic direct preparation, cultures and testing for antibiotic resistance.

RESULTS: A total of 293 instances of SSI were detected in this cohort of 6283 surgical procedures (4.7%). Micobiological species were identified in 129 of 293 SSI (44%). *Staphylococcus aureus* (29.5%) was the most common pathogen causing SSI in trauma and vascular surgery, whereas *Escherichia coli* (20.9%) was more frequently responsible for SSI in visceral surgery. Importantly, not a single case of SSI was caused by antimicrobial-resistant pathogens in this series.

CONCLUSIONS: The spectrum of pathogens causing SSI identified and the very low incidence of antimicrobial resistance at Basel University Hospital validate the continuous use of single-shot single-drug SAP with cefuroxime (plus metronidazole in colorectal surgery).

Key words: *surgical site infection; increased resistance; microbiology*

Introduction

Surgical site infections (SSI) are serious postoperative complications with significant impact on morbidity and mortality. According to the National Nosocomial Infections Surveillance (NNIS) system, SSI are the third most frequently reported nosocomial infections, accounting for 12%–16% of all nosocomial infections among hospitalised patients [1, 2]. *Staphylococcus aureus* remains the most common pathogen causing SSI [3].

Infections with methicillin-resistant *S. aureus* (MRSA) and other antimicrobial-resistant pathogens have steadily increased over time, with current rates of up to 48% [4]. Most epidemiological studies on antimicrobial-resistant pathogens have been performed at teaching facilities, and suggested that community and smaller hospitals encountered fewer antimicrobial-resistant pathogens. More recent data, however, indicated a trend toward comparable occurrences of such pathogens between hospitals of different sizes [5].

Nosocomial infection control is an established in-hospital tool for reduction of the incidence of postoperative complications. The introduction of routine surgical antimicrobial prophylaxis (SAP) was a breakthrough in the prevention of SSI [6]. The antibiotic used should cover the pathogens commonly found in most surgical interventions. Therefore, efforts to identify the outbreaks of antimicrobial-resistant pathogens are required to continuously adjust the type of surgical antimicrobial prophylaxis (SAP). At Basel University Hospital SAP currently consists of single-shot administration of 1.5 g cefuroxime (a second generation cephalosporin), combined with 500 mg metronidazole in colorectal surgery to cover the anaerobic flora. The present study was conducted to describe the epidemiological features of SSI at Basel University Hospital by outlining their microbiological patterns including antimicrobial resistance.

Methods

Patients and procedures

Data were collected during a 2-year study period between 1 January 2000 and 31 December 2001 at Basel University Hospital, following a study protocol which has previously

been described in detail [7]. The study was approved by the institutional review board as part of a broader quality improvement programme which was supported by the hospital executive board. As an observational study it was exempt from the written informed consent requirement. All inpatient procedures performed in the vascular, visceral and trauma Divisions of the Department of General Surgery were consecutively enrolled.

SSI were registered during the hospital stay by the surgical resident on a prospective surveillance form. The attending surgeon cross-checked each form pursuant to Centers of Disease Control and Prevention (CDC) standards. All of the patients' charts were reviewed by a member of our study group in order to collect the information and further screen for SSI not mentioned on the surveillance form. Each suspected or diagnosed SSI was validated by a board-certified infectious disease specialist on the basis of full chart review [8]. Post-discharge surveillance was performed for a minimum duration of 30 days for non-implant surgery and 1 year for implant operations. It consisted of a three step assessment by consultation of outpatient charts, contacting the primary care practitioners who performed post-surgery clinical controls and, finally, by telephone interviews of patients. SSI were classified as superficial, deep and organ/space.

Microbiological evaluation consisted of microscopic direct preparation, cultures and susceptibility testing. Where SSI was suspected, wound swabbing was performed as clinically indicated. Since superficial wound swabbing is difficult to interpret and isolated bacteria are not always responsible for the infection, the decision to treat superficial SSI with antibiotics was based chiefly on clinical grounds rather than on the results of a wound swab. Whenever surgical treatment was indicated, microbiological evaluation was deemed necessary.

The definition of antimicrobial-resistant pathogens included MRSA, gram-negative pathogens expressing broad spectrum betalactamases (ESBL), and multiresistant *P.aeruginosa* and *Acinetobacter*.

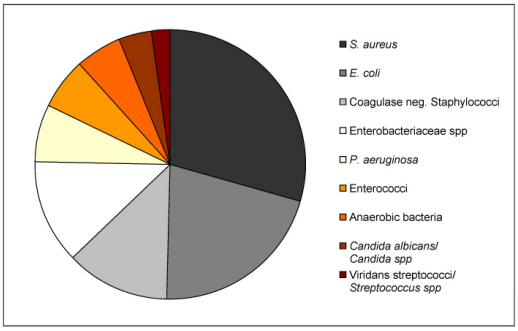

Figure 1

Microbiological results of 129 surgical site infections. Conclusive microbiological evaluation was achieved in 129 of 293 SSI (44%). The identified germ spectrum revealed *S. aureus* in 29.5%, *E. coli* in 20.9%, Coagulase neg. Staphylococci in 12.4%, Enterobacteriaceae spp in 12.4%, *P. aeruginosa* in 7.0%, Enterococciin 6.2%, anaerobic bacteriain 5.4%, *Candida albicans/Candida spp* in 3.9% and Viridans streptococci/*Streptococcus spp* in 2.3%. No antimicrobial-resistant pathogens were detected in this series.

Results

During a 2-year study period 6283 full in-hospital data sets of inpatient invasive procedures were built at Basel University Hospital's Department of General Surgery. A total of 293 instances of SSI were detected (4.7%), 187 of which were recorded on an in-hospital basis, whereas 106 cases were registered after hospital discharge.

According to CDC criteria, 86 SSI (29.4%) were superficial incisional, 88 (30%) were deep incisional and 119 (40.6%) were infections of the organ/space. Of all SSI, 127 (43.4%) referred to CDC wound class 1 (clean), 68 (23.2%) to class 2 (clean-contaminated), 61 (20.8%) to class 3 (contaminated) and 37 (12.6%) to class 4 (dirty-infected) procedures.

In 164 of 293 SSI (56%) microbiological evaluation had either not been performed or was inconclusive. Of those 164 SSI, 76 (46.3%) were classified as superficial and microbiological evaluation was therefore omitted. In the remaining 88 cases (53.7%), microbiological evaluation resulted in inconclusive mixed flora and antibiotic resistance was not tested.

The germ spectrum identified in the remaining 129 SSI (44%) is shown in figure 1. No infection was caused by MRSA or other bacteria with increased antimicrobial resistance during the study period. The germ spectrum was further analysed by division of surgery (i.e., visceral, trauma, or vascular surgery), as shown in table 1. The microbiological pattern differed slightly between the divisions. *S. aureus* was the most common pathogen causing SSI in trauma and vascular surgery, whereas *E. coli* was more frequently responsible for SSI in visceral surgery. SSI were detected after a median postoperative stay of 11 days (10 days in visceral, 12 days in trauma and 13 days in vascular surgery).

Discussion

In the present study we describe the microbiological patterns of 129 SSI at Basel University Hospital which were identified in a series of 293 SSI and assessed in a prospective cohort of 6283 consecutive surgical procedures. Our data confirm prior investigations which found that SSI are primarily caused by gram-positive organisms from the patients' own flora on the skin, mucous membranes, or hollow viscera during surgical procedures [3]. The most common pathogen in visceral surgery was found to be *E. coli*. A possible explanation for this, however, could be the lack of microbiological evaluation of many superficial SSI – typically caused by Staphylococci spp – in this group. Most importantly, there was not a single case of SSI caused by antimicrobial-resistant pathogens in this series. The overall SSI rate of 4.7% in this study is similar to other estimated rates ranging from 2–5% in general surgery patients [9].

Routine surveillance of antimicrobial-resistant pathogens at Basel University Hospital involves colonisation testing at the time of admission. Patients are selected for a variety of reasons, the most common being transfers from abroad or from hospitals within defined regions of Switzerland known for an increased incidence of antimicrobial-resistant pathogens and intravenous drug abuse. Surveillance further

includes preemptive isolation of patients at high risk, contact isolation for colonised or infected patients and decolonisation therapy.

The resistance pattern at Basel University Hospital has remained basically unchanged for the last two decades: The incidence of MRSA is stable at a very low rate of 0.14–0.17/1000 patient days or approximately 1% of all *S. aureus* infections [10, 11]. The only changes during that time have been an increase in gram-negative pathogens expressing broad spectrum beta-lactamases (ESBL) [12] in the outpatient clinics and an increase in *Clostridium difficile*-associated diarrhoea [13]. In contrast, an increasing number of antimicrobial-resistant pathogens have been detected in recent decades in hospitals worldwide. The exact prevalence, however, seems to vary considerably. For instance, the highest prevalence in Europe was observed in hospitals in Portugal (54%), whereas, in line with the results of the present study, the lowest prevalence was found in institutions in Switzerland and the Netherlands (2%) [14].

The main limitation to this report is the low microbiological identification rate of 44% (129 of 293 SSI) that may have biased the distribution pattern of pathogens causing SSI in this study. However, according to CDC criteria [8] microbiological analysis is neither mandatory for the diagnosis of SSI nor routinely performed in all SSI, due its high cost. Whenever SSI is suspected or diagnosed, only clinically relevant microbiological samples are cultured, and the patient then receives standard treatment. As a result, the identification rate of 44% in this study is very similar to the rates in other published series [15].

In summary, the incidence of antimicrobial-resistant pathogens at Basel University Hospital remains very low, despite quite different trends in foreign hospitals, validating the continuous use of single-shot single-drug SAP with cefuroxime (plus metronidazole in colorectal surgery).

Study funding / potential competing interests

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The authors declare that they have no conflicts of interest relevant to the manuscript submitted to Swiss Medical Weekly.

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Table 1: Identified germ spectrum stratified by division of surgery (i.e., visceral, trauma, or vascular surgery).

Characteristic		Visceral surgery	Trauma surgery	Vascular surgery	Total
SSI	Total	147 (50.2%)	81 (27.6%)	65 (22.2%)	293
	Microbiology known	65 (50.4%)	36 (27.9%)	28 (21.7%)	129
SSI causing pathogens	*S. aureus*	10 (26.3%)	18 (47.4%)	10 (26.3%)	38
	E. coli	20 (74.1%)	2 (7.4%)	5 (18.5%)	27
	Coagluase neg. Staphylococci	7 (43.8%)	6 (37.5%)	3 (18.7%)	16
	Enterobacteriaceae spp	11 (68.8%)	4 (25.0%)	1 (6.2%)	16
	P. aeruginosa	3 (33.3%)	1 (11.1%)	5 (55.6%)	9
	Enterococci	5 (62.5%)	1 (12.5%)	2 (25.0%)	8
	Anaerobic bacteria	4 (57.1%)	3 (42.9%)	0	7
	Candida albicans/ *Candida spp*	3 (60.0%)	0	2 (40.0%)	5
	Viridans streptococci/*Streptococcus spp*	2 (66.7%)	1 (33.3%)	0	3

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