Activity and impact on antibiotic use and costs of a dedicated infectious diseases consultant on a septic orthopaedic unit

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Summary The Orthopaedic Service of the Geneva University Hospitals engages dedicated infectious disease (ID) specialists to assist in the treatment of infected patients. We investigated the daily clinical activity and the impact on antibiotic costs in the Septic Unit since 2000.


Results: According to the survey, the ID specialist performed 265 first-time and 1420 follow-up consultations (average of 11.4 consultations per working day). In 88% of cases the antibiotic regimen initiated by the surgeons was approved. When the ID specialist had to change antibiotic treatment, it was for de-escalation in 43.7%, discontinuance in 32.4%, and initiation in 24.4% of cases. From April 2007 to March 2008, the ID specialist decreased total antibiotic use by 43 DDD/100 patients-days (p = 0.0006) in the Septic Unit. Direct antibiotic costs decreased by US$64,380 over the same period, equal to the annual salary of the ID specialist. There was no change in the number of recurrent infections.
Introduction

Infections following orthopaedic procedures represent a heavy burden for patients, hospitals and society in terms of morbidity and financial costs. Although their incidence is low, their management can be complicated and prolonged.

While the utility of an infectious disease (ID) consultation has been previously contested, ID specialists are useful in medical units because they may enhance the appropriateness of antibiotic therapy and thus help to reduce hospital length of stay and medical costs. Expenditures for antimicrobial agents can account for as much as 50% of a hospital’s total drug budget. Furthermore, a positive impact of ID specialists has been reported for intensive care units (ICU) and the management of bacteraemia and for specialist units in tertiary hospitals. To the best of our knowledge there is only one published article describing the effect of ID advice for infections on orthopaedic units.

Beginning in 2000, the Orthopaedic Surgery Service of the Geneva University Hospital has successfully engaged dedicated ID specialists. We investigated the impact of the ID specialists on antibiotic use in the orthopaedic units. In a second step, we analysed separately the impact and clinical activity of the current ID consultant who has special experience in hospital epidemiology and antibiotic policy, in order to know if this type of experience further decreased antibiotic use and related costs than ID consultations by specialists without this experience.

Methods and setting

Setting

The Geneva University Hospital is a 2200-bed tertiary hospital serving a population of 800,000 people. The Orthopaedic Surgery Service has four general orthopaedic units with 97 acute care beds and a septic unit with 22 beds. In 2007, the service had 4600 annual admissions, 5400 surgical interventions, and 15,000 ambulatory consultations.

History of infectious diseases consultations in the orthopaedic service

The study encompasses the period from January 2000 to March 2008. Prior to this, ID consultations were performed by the on-call physician from the Service of Infectious Diseases who was responsible for the entire hospital. These ID consultants were accompanied by rotating junior assistants who changed every two to four weeks, without the presence of a dedicated ID fellow. In 2000, the Orthopaedic Service engaged for the first time a full-time dedicated ID specialist.

Conclusions: The main antibiotic-related activity of the dedicated orthopaedic ID specialist in Geneva our institution was to discontinue or adjust a pre-existing antimicrobial therapy. This activity significantly reduced antibiotic use and related costs on a septic orthopaedic unit.

Specific activity of the dedicated ID consultant

His/her specific activity consisted in ID consultations for problems of orthopaedic patients in the field of infectiology and internal medicine. He/she could have been called by all healthcare workers in charge of the patients. Alternatively, he/she could have discovered infectious and internist problems during daily rounds in the septic unit or might have been informed by the microbiologists about the growth of unusual pathogens in specimens obtained from the Orthopaedic Service. Additionally, there were established routine encounters between the orthopaedic surgeons and the ID specialist twice a day: at the morning report at 7:30 a.m. and during the late afternoon round.

Besides the clinical work, the ID consultant conducted epidemiologic or laboratory research in septic orthopaedics and foreign body infections. The last ID consultant additionally assumed the task of infection control and hospital epidemiology in the Orthopaedic Service.

Four ID physicians in orthopaedics

Four physicians have so far conducted these dedicated ID consultations. From September 2000 to September 2003 it was a senior ID specialist in osteoarticular infections, followed by another osteoarticular ID specialist from October 2003 to September 2006. Between October 2006 and March 2007 an internist without specialised ID training assumed the task with backup support from the Service of Infectious Diseases. And lastly, from April 2007 to March 2008, the task was assumed by an ID consultant without special expertise in osteoarticular infections but with a three-year experience in hospital epidemiology and antibiotic policy. This latter physician was engaged half-time by the Orthopaedic Service with an annual salary of US$66,530, and in addition regularly worked for the Infection Control Program and the Service of Infectious Diseases (12 weeks of general ID consultations).

Institutional antibiotic policy

During the study period there was no institutional policy in our hospital regarding antibiotic use; restriction was rare. At the pharmacy level, refusal to dispense a drug was uncommon and all physicians were able to prescribe and initiate any antimicrobial agent; except for the geriatric setting. This was particularly true for orthopaedic surgeons, as they did not need to consult the ID specialist before prescribing antimicrobial agents. In turn, the dedicated ID consultant was free to modify antibiotic therapy at any time in the Orthopaedic Service without prior consulting the surgeons.
Activity assessment

Since our study was retrospective, no detailed data of clinical activity could have been retrieved for preceding years, and would have been erroneous. For example, consultations by phone were not notified in medical records. In order to circumvent this methodological problem, we performed a prospective survey during three consecutive months and considered it as representative of the study period. From January to March 2008 the current ID physician noted the daily activity at the end of each working day, and entered this information into an Excel worksheet.

Audit of antibiotic prophylaxis

During the last five weeks of the study compliance with antibiotic prophylaxis recommendations was assessed by retrospectively reviewing individual patient files. An intravenous dose of 1.5 g of cefuroxime was the standard antibiotic regimen for preoperative prophylaxis in orthopaedic surgery. In cases of colonisation and/or infection due to methicillin-resistant Staphylococcus aureus (MRSA), 1 g of iv vancomycin was the agent of choice. The prophylaxis was prescribed by the surgeons, and other than in cases of heavily contaminated open fractures the maximum duration was limited to 24 h.\textsuperscript{16}

Data collection

Antibiotic usage data were provided by the pharmacy. The assumed average maintenance dose per day for a drug used for its main indication in an adult was expressed as a monthly aggregated defined daily dose (DDD) and normalized per 100 patients-days (antibiotic use density).\textsuperscript{17} In order to neutralize the effect of varying antibiotic purchasing costs over time, all costs were standardized to the level of 2008. Electronic databases from the Laboratory of Bacteriology, the Geneva Arthroplasty Registry,\textsuperscript{18} the Septic Orthopaedic Cohort and the Hospital’s Administrative Coding were retrospectively searched for orthopaedic infections.

For the analysis of aggregate data on antibiotic use no ethical committee approval was necessary.

Surveillance of infections

Infection surveillance on the Orthopaedic Service does not routinely assess all pathogens or infections. For example, urinary tract infections, conjunctivitis, superficial surgical site infections, bronchitis, sinusitis, etc. are not routinely recorded in the hospitals coding system and are not mandatorily mentioned in the surgical discharge letters. Moreover, a significant part of consultations for infections in the ambulatory setting occur orally. Hence we cannot count all possible infections, let alone attribute their management directly to the ID specialist.

Instead, our surveillance system concentrates on key infections of epidemiologic interest: Since 1995 the hospital has conducted a prospective bacteraemia surveillance based on modified definitions\textsuperscript{19} from the Center of Disease Control.\textsuperscript{20} Staphylococci are responsible for at least two-thirds of all orthopaedic infections;\textsuperscript{21,22} and MRSA is endemic at Geneva University Hospital.\textsuperscript{23,24} Hence, we conduct a surveillance for staphylococcal (MRSA, methicillin-sensitive S. aureus (MSSA), and coagulase-negative S. aureus) implant-related infections. Moreover, infections of total joint arthroplasties are surveyed in a cohort study.\textsuperscript{18} This staphylococcal implant and arthroplasty infection surveillance also includes infections attributed to other hospitals, but which were treated in our service. Concerning infection surveillance, the study was approved by the local Ethical Committee (No. 08-029R, 05-041, and 08-017R). No informed consent was required.

Statistical analyses

Since temporally sequenced observations on antibiotic use are not independent, applying simple regression analysis is inappropriate.\textsuperscript{25} Therefore, time series analysis was used to examine trends and autocorrelations over time. We chose autoregressive integrated moving average (ARIMA) models using the Box–Jenkins method allowing the stochastic dependence of consecutive data over time.\textsuperscript{26} We constructed an intervention model to determine if the presence of an ID specialist significantly changed antibiotic use and costs, as previously described.\textsuperscript{24} In an intervention model, the time series is constituted by an indicator variable containing discrete values. It may change due to an intervention, which will interrupt the stationary evolution of the series, which, in the absence of the intervention, is usually assumed to be a pure ARIMA process.\textsuperscript{26} To evaluate the effect of the intervention we created dummy variables, with 0 and 1 representing pre-intervention and post-intervention periods, respectively. For each individual series we identified and fitted an ARIMA model according to Box and Jenkins\textsuperscript{26} and therefore performed the following steps: we first checked if the series were stationary (= having a constant mean and variance); then identified the model by determining the ARIMA model orders (p,d,q) with the autocorrelation (ACF) and partial autocorrelation (PACF); then estimated model parameters by unconditional least squares method; and finally checked the adequacy of the model, i.e. the residuals to be white noise, and statistical significance of the parameters. Among different models we chose the most parsimonious one with the fewest parameters. The generated coefficient $R^2$ measures the overall fit of the regression line, expressing how close the points are to the estimated regression line in the scatter plot. In other terms, $R^2$ is the fraction of the variance of the dependent variable explained by the regression.

The number of various infections throughout the calendar years was described by strata. Since the numbers of events were small, we did not perform the Poisson regression analysis.

EViews 6 software (QMS, Irvine, USA) was used, and a $p$-value of <0.05 (two-tailed) was considered as statistically significant.

Results

Changes in antibiotic costs

Overall changes after arrival of the ID consultants on the septic ward

A reduction of antibiotic costs was documented following the arrival of the first dedicated ID consultant on the septic
unit (Fig. 1). They rose in parallel to an increase of patient numbers during the period of the internist and fell down by the arrival of the ID consultant with experience in antibiotic use. Compared to data from 1999, the corresponding antibiotic-related cost changes per 100 patients-days were $194 in 2000 (−8%), $600 in 2001 (−25%), $407 in 2002 (−16%), $586 in 2003 (−24%), $380 in 2004 (−16%), $1565 in 2005 (+6%), $39 in 2006 (+2%), and $588 in 2007 (−24%).

This success of the ID consultants was partly due to a decrease in intravenous medication, since ID consultants disposed about a more detailed knowledge of oral bioavailability and bone penetration of antibiotic agents. On average, the daily peroral administration of a given antibiotic was cheaper than the intravenous application throughout the study period. Moreover, the nurses’ time commitment for intravenous administration cost approximately US$5 per intravenous administration. Prior to the engagement of the first ID specialist, antibiotic treatment for at least the first two weeks had been almost exclusively administered by the intravenous route. Following ID specialist arrival, the annual number of venous lines diminished from 13,519 in 1999 to 10,046 in 2000 (−5.7%), and further to 7284 by 2002 (−46.1%). The early switch from intravenous to peroral regimens remained enhanced throughout the study period (Fig. 2). However, because of lack of data about antibiotic prophylaxis before 2005, we were unable to evaluate whether this decrease in total antibiotic use was also partly due to better adherence to perioperative antibiotic prophylaxis.

Changes following the engagement of an ID specialist with experience in infection control

In the final year, with an ID specialist experienced in infection control and antibiotic stewardship, overall antibiotic use and subsequent costs further decreased on the septic unit, but not on other orthopaedic units (Table 1). On the Septic Unit average antimicrobial use over the entire study period was 135 DDD/100 patients-days. The current ID specialist decreased total antibiotic use in the last year additionally by 43 DDD/100 patients-days (p = 0.0006), and direct antibiotic costs decreased by US$64,380. In time series analysis, statistical significance was already achieved after one month (Table 1). Of note, the relatively expensive use of linezolid vanished almost entirely.

For the general orthopaedic units average antimicrobial use over the study period was 23 DDD/100 patients-days (17% of the DDD of the Septic Unit). In this setting, cefuroxime use significantly increased in the last year, whereas the use of other antibiotics remained statistically unchanged.

Detailed clinical activity of the current ID specialist

In the last year of the study, the current ID specialist performed 265 initial and 1420 follow-up consultations. Of a total number of 592 consultations in the prospective survey sample which covered 52 working days, 466 (78.7%) were conducted at bedside and 100 (16.9%) with ambulatory patients. An average of 11.4 consultations was conducted per working day (range, 1–27). Four hundred thirty consultations (72.6%) were conducted on the Septic Orthopaedic Unit, 71 (12%) on other orthopaedic units, and 91 (15.4%) on other services or for ambulatory patients with osteoarticular or soft tissue infections.

In 521 situations (88%), the antibiotic regimen initiated by orthopaedic surgeons was approved. Whenever the ID specialist had to change antibiotic therapy in the remaining 71 cases (12%), it consisted of adaptation or de-escalation in 31 cases (43.7%), discontinuation in 23 cases (32.4%), and initiation of a particular antibiotic treatment in 17 cases (23.9%).

Audit of preoperative antibiotic prophylaxis

A total of 172 operations were reviewed and the results were reassuring, with full compliance to all aspects of antibiotic prophylaxis recommendations in 163 cases (95%). This compliance was 100% regarding the choice of antibiotic agent, but optimal timing and duration was achieved only in 157 (91%) and 31 cases (18%), respectively. The excess of prophylaxis duration was witnessed for cefuroxime in the non-septic units.
Operations and patients

The number of patients hospitalised annually rose continuously from 3646 in 1999 to 4384 in 2007. In addition, the number of annual surgical interventions increased from 2832 to 5374. The number of annual hospitalisation-days remained stable at 50,022 in 1999 and 50,450 in 2006. The case-mix of the patients did not substantially change over the study years according to the Geneva Arthroplasty Register. The average age of patients undergoing hip or knee arthroplasty was 68 years in 1999 and 69 years in 2007, with a mean number of co-morbidities of 1.39 and 1.49 per patient, respectively.

Infections

When stratified into double-calendar years, the number and rates of staphylococcal implant-related infections fell sharply after the arrival of the first ID consultant, but then slightly rose during the study period. Eight MRSA infections occurred before 1999, 5 during 2000–2001, 9 during 2002–2003, 12 during 2004–2005, and 12 infections occurred during 2006–2007, corresponding to 0.11, 0.03, 0.06, 0.08, 0.08 MRSA infections per 100 patients-days. The corresponding absolute numbers for MSSA infections were 4, 4, 9, 22, and 16 during 2006–2007, or 0.05, 0.03, 0.06, 0.14, and 0.12 infections per 100 patients-days. For implant infections due to coagulase-negative staphylococci, the numbers in the aforementioned time periods were 6, 6, 8, 14, and 12, respectively; or 0.08, 0.04, 0.05, 0.09, and 0.09 per 100 patients-days. The number of arthroplasty infections in the double-calendar years was 9, 12, 28, 27, and 36. This corresponds to incidence densities of 0.12, 0.08, 0.18, 0.17, and 0.26 infections per 100 patients-days. The number of infections and their rates is not automatically attributed to the Orthopaedic Service, nor do they explain an insufficient antibiotic treatment. For example, the number of infection recurrences among previously treated arthroplasty infections was 0, 1, 4, 3, and 0 episodes in the aforementioned double-year calendar periods. Only the surveillance of bacteraemia reflects the infectious burden generated by the service. Here, the number of bacteraemia episodes attributed to the Orthopaedic Service in the same double-calendar years was 26, 24, 25, 14 and 17, respectively. Thus, there was even a tendency to decline in bacteraemia in recent years.

Discussion

We have demonstrated the positive impact of a dedicated orthopaedic ID specialist in reducing antibiotic use and related costs on a septic orthopaedic unit. We further demonstrated an additional decrease in total antibiotic use and direct costs following the engagement of an ID specialist with experience in infection control, which may presumably be explained by a better sensitization of the latter to antibiotic control policies, be it microbiological or financial. Since the costs data were standardized, periodical changes in the antibiotic prices were excluded. Our annual antibiotic-related costs savings alone were equal to the annual salary of the ID specialist. This decrease in antibiotic costs was achieved despite a constant rate of infection surrogates and did not lead to an increase in the overall number of infections or recurrence of arthroplasty.

Figure 2  Antibiotic use on the entire Orthopaedic Service at the Geneva University Hospital. Three periods are displayed: Period before the arrival of the first infectious diseases (ID) specialist, a period of ID specialist, and the last year with the engagement of an ID specialist with experience in Infection Control and antibiotic policy. DDD: Daily defined doses. IV: Intravenous application.
Table 1  Use of antibiotics (daily defined dose per 100 patients-days) throughout the study period and specific changes at the engagement of a dedicated infectious diseases specialist with experience in Infection Control.

<table>
<thead>
<tr>
<th>Antibiotic (class)</th>
<th>Year 2000</th>
<th>Year 2001</th>
<th>Year 2002</th>
<th>Year 2003</th>
<th>Year 2004</th>
<th>Year 2005</th>
<th>Year 2006</th>
<th>Year 2007</th>
<th>Changes</th>
<th>Begin of effect</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Septic Ward</strong></td>
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</tr>
<tr>
<td>All penicillins</td>
<td>4575, 55%</td>
<td>5623, 50%</td>
<td>5635, 47%</td>
<td>3888, 35%</td>
<td>3998, 36%</td>
<td>2697, 25%</td>
<td>3711, 42%</td>
<td>3151, 40%</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Benzylpenicillin</td>
<td>38, 0%</td>
<td>312, 3%</td>
<td>318, 3%</td>
<td>17, 0%</td>
<td>0, 0%</td>
<td>0, 0%</td>
<td>0, 0%</td>
<td>385, 5%</td>
<td>+5.7</td>
<td>1 month</td>
<td>0.0003</td>
</tr>
<tr>
<td>Flucloxacillin</td>
<td>1619, 19%</td>
<td>1487, 13%</td>
<td>1325, 11%</td>
<td>640, 6%</td>
<td>777, 7%</td>
<td>453, 4%</td>
<td>498, 5%</td>
<td>433, 5%</td>
<td>−9.6</td>
<td>1 month</td>
<td>0.0115</td>
</tr>
<tr>
<td>Amoxicillin−clavulanate</td>
<td>1958, 23%</td>
<td>3338, 30%</td>
<td>2561, 21%</td>
<td>2906, 26%</td>
<td>2519, 23%</td>
<td>1592, 15%</td>
<td>1978, 22%</td>
<td>1509, 19%</td>
<td>−13.3</td>
<td>1 month</td>
<td>0.0304</td>
</tr>
<tr>
<td>Cephalosporins</td>
<td>675, 8%</td>
<td>795, 7%</td>
<td>1072, 9%</td>
<td>1028, 10%</td>
<td>497, 5%</td>
<td>530, 5%</td>
<td>241, 3%</td>
<td>777, 10%</td>
<td>ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Carbapenems</td>
<td>574, 7%</td>
<td>258, 2%</td>
<td>185, 2%</td>
<td>150, 1%</td>
<td>179, 2%</td>
<td>261, 2%</td>
<td>235, 3%</td>
<td>410, 5%</td>
<td>ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>585, 7%</td>
<td>1684, 15%</td>
<td>1021, 8%</td>
<td>1677, 15%</td>
<td>1658, 15%</td>
<td>2239, 21%</td>
<td>1836, 21%</td>
<td>1202, 15%</td>
<td>−13.0</td>
<td>3 months</td>
<td>0.0170</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>191, 2%</td>
<td>543, 5%</td>
<td>1375, 11%</td>
<td>1770, 16%</td>
<td>1646, 15%</td>
<td>2120, 20%</td>
<td>1084, 12%</td>
<td>742, 9%</td>
<td>ns</td>
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</tr>
<tr>
<td>Cotrimoxazol</td>
<td>68, 1%</td>
<td>165, 2%</td>
<td>610, 5%</td>
<td>853, 7%</td>
<td>670, 6%</td>
<td>783, 8%</td>
<td>330, 4%</td>
<td>190, 2%</td>
<td>ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Vancomycin</td>
<td>660, 8%</td>
<td>755, 7%</td>
<td>357, 3%</td>
<td>537, 5%</td>
<td>651, 6%</td>
<td>659, 6%</td>
<td>619, 7%</td>
<td>604, 7%</td>
<td>ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Rifampin</td>
<td>332, 4%</td>
<td>1046, 9%</td>
<td>1319, 11%</td>
<td>830, 7%</td>
<td>1153, 10%</td>
<td>724, 7%</td>
<td>427, 5%</td>
<td>504, 6%</td>
<td>−7.1</td>
<td>1 month</td>
<td>0.0465</td>
</tr>
<tr>
<td>Linezolid</td>
<td>0, 0%</td>
<td>0, 0%</td>
<td>85, 1%</td>
<td>80, 1%</td>
<td>130, 1%</td>
<td>291, 3%</td>
<td>112, 1%</td>
<td>10, 0%</td>
<td>ns</td>
<td>ns</td>
<td></td>
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<tr>
<td><strong>Non-septic wards</strong></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Cefuroxime</td>
<td>1303, 22%</td>
<td>1450, 22%</td>
<td>1311, 19%</td>
<td>1186, 22%</td>
<td>1766, 28%</td>
<td>1648, 27%</td>
<td>2228, 35%</td>
<td>3322, 38%</td>
<td>+4.3</td>
<td>Immediately</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

DDD = Daily defined dose, ns = not significant % indicate the proportion of all antibiotics used per calendar year.

<table>
<thead>
<tr>
<th>Changesa</th>
<th>Begin of effect</th>
<th>p-Value</th>
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<tbody>
<tr>
<td>ns</td>
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<tr>
<td>+5.7</td>
<td>1 month</td>
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<tr>
<td>−9.6</td>
<td>1 month</td>
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<td>−13.3</td>
<td>1 month</td>
<td>0.0304</td>
</tr>
<tr>
<td>−13.0</td>
<td>3 months</td>
<td>0.0170</td>
</tr>
<tr>
<td>ns</td>
<td>ns</td>
<td></td>
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<tr>
<td>ns</td>
<td>ns</td>
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<tr>
<td>−7.1</td>
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<td>0.0465</td>
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<td>ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>+4.3</td>
<td>Immediately</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Changes in DDD of corresponding antibiotic use per 100 patients-days after the ID specialist with experience in Infection Control.

Time delay until the effect of antibiotic reduction after the engagement of the dedicated ID specialist with experience in Infection Control.

I. Uckay et al.
infections, the most powerful surrogate for orthopaedic implant-associated infections. Since we did no differentiate between nosocomial vs. community-acquired infections, or between home-grown vs. external infections, we cannot extrapolate the potential influence of our local infection control policies. However, a hospital-wide hand hygiene enhancement, led in 2006 to a transient reduction of MRSA transmission, suggesting that strict nosocomial infections might not explain the persistence of constant infection rates. This assumption is supported by a decrease of bacteraemia episodes attributed to the service. Moreover, the higher rate of arthroplasty infections was probably due to an influx of infected patients from peripheral hospitals due to change of refunding policies in Switzerland in recent years.

The lack of infection recurrence among previously treated arthroplasty infections underlines a successful curative approach of our antibiotic therapies.

In the cost calculation, other treatment-related costs such as nursing resources, diagnostic examinations or surgical interventions are not even included. The reduction effect on costs was substantial and similar to ID consultations—such as nursing resources, diagnostic examinations or curative approach of our antibiotic therapies.

The second key message of our study is that success requires the continuous presence of an ID specialist on the unit. In non-septic orthopaedic units where the ID specialist consulted only 12% of the time, and where the surgeons themselves determined the duration of prophylaxis, there was an increase in use of cefuroxime due to a prolonged duration of perioperative prophylaxis.

Our study has several limitations. First, any potential factors influencing antibiotic use may have remained undetected. This included hospital-wide interventions to reduce healthcare-associated infections (hand hygiene campaign, educational programs, etc.) that occurred in our hospital with an increase in alcohol-based hand rub consumption and a transient reduction in general antibiotic use. However, there were no interventions regarding antibiotic use or prophylaxis. Furthermore, the numbers of patients, staphylococcal infections, and bacteraemia episodes did not change, making a major alternative explanation unlikely. Second, we were unable to separate out the individual impact of the duration of antibiotic treatment, the reduction of daily doses, or the choice of antimicrobial agent. The duration of antibiotic therapy may play a role for minor soft tissue infections, since the ID consultant more frequently stopped a treatment than initiated it. On the other hand, the duration of antibiotic treatment for staphylococcal infections remained constant during the study periods (data not shown). Third, we did not directly measure the influence of the dedicated ID specialist on clinical outcomes such as cure rates as this was not an objective of the study. But the lack of an increase in the recurrence rate of staphylococcal implant-associated infections would be an argument against significant changes in cure rates since staphylococci are the most frequent pathogens in orthopaedic infections. In a prospective study of two groups of patients with musculoskeletal infections, Ziran et al. treated one group with the assistance of an on-call ID specialist and the other with a dedicated ID specialist. Overall, there was a 78% success rate in the group with a dedicated ID specialist as compared to 42% in the other group. Forth, this study was uncontrolled because all ID consultations on our service were performed by a dedicated physician since 2000. And lastly, patients with a good clinical course following initiation of antibiotic treatment, and patients with recurrent infection occurring in another hospital may have been undetected. However, since the Geneva University Hospital is the largest hospital in the area we consider this possible selection bias as minimal.

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