

# Antibiotic misuse in medium-sized Swiss hospitals

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## Summary

Antibiotics account for a substantial proportion of hospital drug expenditures and tend to be misused or overused, generating unnecessary costs and causing the emergence of resistant bacteria. Antibiotic use was evaluated in a one-day prevalence study performed on the surgical and medical wards of eight Swiss non-university hospitals. 173 of the 695 inpatients present (25%) were on antibiotics and 163 could be evaluated. 35 prescriptions were secondary to an infectious disease consultation. 60 of the remaining 128 (47%) were considered inappropriate, of which 17 (28%) lacked any indication for antibiotic use. The rates of mis-

use were higher in surgery than in medicine (58 vs. 34%; OR = 2.5 [95% CI: 1.1–5.9]), and higher for prophylaxis than for treatment (72 vs. 41%; OR = 4.1 [95% CI: 1.3–15.5]). Savings of 545 euros (95% CI: from –116 to 1,206 euros) on the study day and 6,256 euros (95% CI: from –2,221 to 14,732 euros) for the total treatments or prophylaxis administered would have resulted from infectious disease consultations.

*Key words: antibiotic misuse; Swiss hospitals; antibiotic costs*

## Introduction

Since the discovery of antibiotics many substances have become available for the treatment of infections. Unfortunately, following several decades of optimism, the inappropriate use of these drugs has resulted in the current alarming situation of ever-growing bacterial resistance, accompanied by unwanted side effects and high costs [1–5]. Due to the numerous classes of available agents, the various mechanisms of resistance and the new threats from emergent infectious diseases among immunocompromised or migrant populations, the non-specialist faces particular challenges nowadays in keeping abreast of latest develop-

ments in the treatment of infections. Antibiotic misuse and over-use may therefore be increasingly frequent and increase the selection pressure leading to the emergence of resistant bacteria, thus helping to create a vicious circle in which physicians tend to prescribe more “false security” treatments with broad spectrum agents for excessive periods of time.

The aim of this study was to evaluate the rates of erroneous antibiotic prescription and the resultant unnecessary costs in 8 medium-sized hospitals in western Switzerland.

## Methods

This one-day prevalence study was conducted on September 8, 1997. All the medical and nursing records of patients present on internal medicine and surgical wards (including patients with orthopaedic and urological diseases) of eight Swiss non-university acute-care regional reference hospitals (150–300 beds) were investigated by the hospital's infectious diseases (ID) consultant. In one hospital only the internal medicine ward was investigated as the surgical ward team was unwilling to take part in the study. This circumstance may slightly modify the conclusions pertaining to that particular hospital.

For every patient on antibiotics a standardised questionnaire was completed including information on the antimicrobial agents administered, the diagnosed condition for which they were given, any microbiological results, whether the prescription was based on those results or empirical, the route of administration, the dosage and duration of treatment. “Antibiotic treatment” meant only treatment by antibacterial agents.

Patients whose treatment had been prescribed secondary to an ID consultation were excluded from the analysis as far as therapeutic errors were concerned but re-

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tained in the analysis for the other parameters studied. That was why the ICU patients were deliberately excluded in view of the high level of infectious risk and the nearly systematic administration of anti-infectious drugs under the supervision of an infectious disease consultant. The treatments were evaluated by each hospital's ID consultant according to the recommendations of the Infectious Diseases Society of America or of the Swiss Society for Infectious Diseases, with the ID consultant providing his own proposals. Seven out of eight ID consultants were specialists and the last has long experience of ID training. The ID consultants' decisions were adopted as the gold standard in this study although their considerations might differ slightly among themselves and not necessarily be always correct. Errors were classified as follows: (1) no indication for antibiotic therapy, (2) too wide or too narrow a spectrum of activity, (3) inappropriate route of

administration, (4) substance with insufficient penetration at the site of infection, (5) inadequate dosage, (6) inadequate duration.

The rates of inappropriate treatment were studied globally and for each hospital, while comparisons were drawn between medical and surgical wards. Odds ratio stratified for hospitals are calculated with StatXact, using exact mid-p corrected confidence interval (95% CI). Costs were evaluated according to public prices and converted into euros. The actual costs were compared with the costs generated by the "ideal" therapy as proposed by the ID consultant. Cost savings (difference between prescribed and "ideal" therapy) were evaluated with 95% confidence intervals by means of general mixed model analysis of variance with random effects for hospitals and wards (using BMDP3V). Box plots are also provided.

## Results

On the day of the study 695 inpatients were present on the 8 internal medicine and 7 surgical wards (including orthopaedic and urological diseases) involved, 173 (25%) being on antibiotics of whom 163 could be evaluated. Ten patients were excluded as major information was missing from their questionnaires. The proportion of patients on antibiotics varied from 12–33% between hos-

pitals; 22% (10–38%) in internal medicine wards and 26% (15–35%) in surgical wards (table 1). The most frequent indication for antibiotics was respiratory tract infection (26%), followed by urinary tract infection (21%), surgical prophylaxis (16%), gastrointestinal infections (12%), skin and soft tissue infections (10%), joint and bone infections (8%), bacteraemia and sepsis (5%) and infections of the central nervous system (1%). 70% of the prescriptions were empirical while 30% were related to microbiologically confirmed infections.

The total number of antibiotics prescribed was 197. 34 patients were receiving two antibiotics. None had triple therapy. The agents used were, in descending order of frequency, penicillins with or without beta-lactamase inhibitors (33%), cephalosporins (21%), quinolones (20%), metronidazole (6%), trimethoprim-sulfamethoxazole (4%), macrolides (3%) and aminoglycosides (3%). Only three patients were on glycopeptides.

35 patients were on agents prescribed secondary to ID consultation. They were thus excluded from the error assessment to avoid self-evaluation. 60 of the remaining 128 patients (47%) were considered to be receiving inappropriate treatment. As shown in table 1, this proportion varied from 29–73% between hospitals (the lower ex-

**Table 1**  
Number and proportion of patients on antibiotics and of antibiotic misuses, by hospital and by ward.

Hospital	ward <sup>1</sup>	patients on antibiotics/ total, N (%)	misuses/ prescriptions evaluated <sup>2</sup> , N (%)
A	all	35/115 (30)	14/32 (44)
	medicine	13/52 (25)	4/12 (33)
	surgery	22/63 (35)	10/20 (50)
B	all	11/95 (12)	3/6 (50)
	medicine	6/61 (10)	0/1
	surgery	5/34 (15)	3/5 (60)
C	all	13/55 (24)	7/13 (54)
	medicine	6/31 (19)	3/6 (50)
	surgery	7/24 (29)	4/7 (57)
D	all	34/155 (22)	11/22 (50)
	medicine	19/86 (22)	5/11 (45)
	surgery	15/69 (22)	6/11 (55)
E	all	16/49 (33)	11/15 (73)
	medicine	5/13 (38)	2/4 (50)
	surgery	11/36 (31)	9/11 (82)
F	all	17/85 (20)	4/13 (31)
	medicine	7/37 (19)	0/3 (0)
	surgery	10/48 (21)	4/10 (40)
G	all	8/27 (30)	4/6 (67)
	medicine	5/16 (31)	1/3 (33)
	surgery	3/11 (27)	3/3 (100)
H	medicine only	29/114 (25)	6/21 (29)

<sup>1</sup> Only internal medicine and surgical wards (including urologics and orthopaedics) were examined.

<sup>2</sup> The number of prescriptions evaluated may be smaller than the number of patients on antibiotics because prescriptions resulting from an ID consultation were excluded (see text).

**Table 2**

Prevalence of the categories of antibiotic misuse.

Category	prevalence <sup>1</sup> (n = 128)
No indication for the administration of antibiotics	13%
Too long duration	10%
Too wide spectrum of activity	7%
Too narrow spectrum of activity	7%
Insufficient penetration at the site of infection	3%
Inappropriate route of administration	3%
Incorrect dosage	3%

<sup>1</sup> Number of patients in the given category/number of patients on antibiotics without a prior ID consultation

treme being found for the hospital in which only the internal medicine ward was included); 34% (0-50%) in the internal medicine wards and 58% (40-100%) in the surgical wards. The odds ratio on receiving inappropriate treatment in surgery was 2.5 (95% CI: 1.1-5.9) as compared with inter-

nal medicine. The proportions of misuse were 72% (18/25) for prophylaxis and 41% (42/103) for the treatment of infections, with a odds ratio of 4.1 (95% CI: 1.3-15.5). They did not differ between antibiotics given on an empirical basis (46/97, 47%) and on the basis of a microbiological result (14/31, 45%). The prevalence and relative frequency of the different categories of antibiotic use are shown in table 2.

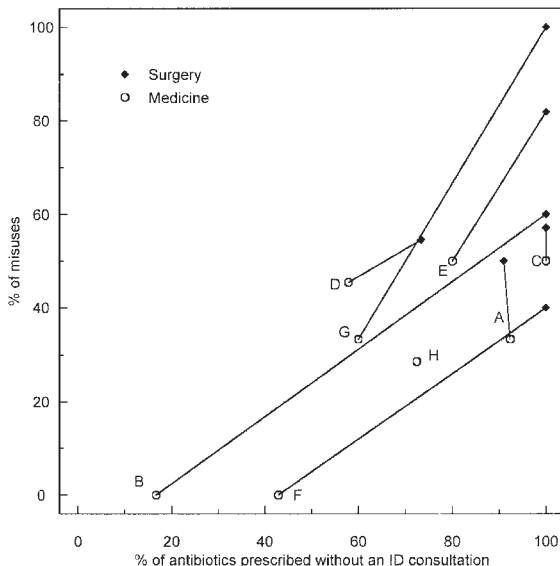
Figure 1 shows that in each participating hospital a larger proportion of surgical than of medical patients were receiving antibiotics without an ID consultation (horizontal axis). On the other hand, this figure also shows that the rates of antibiotic misuse in patients treated without specialist advice were consistently higher on surgical than on medical wards (vertical axis).

The total cost of the antibiotics used on the study day (for all 163 patients) was 5,027 euros (31 euros/patient). Had recommendations of ID consultants been sought and followed, this cost would have been 4,590 euros (28 euros/patient). Considering the numbers of days on antibiotics at the time of the study and assuming that no change had occurred in the agents administered, the total cost of antibiotics amounted to 84,125 euros (516 euros/patient) compared with 77,762 euros (477 euros/patient) if the treatments proposed by the ID consultants had been followed.

For the 128 patients without ID consultation, while taking into account hospital and ward, this corresponds to a saving of 545 euros (95% CI: from -116 to +1,206) on the study day or 6,256 euros (95% CI: from -2,221 to +14,732) for the total days on antibiotics. This corresponds to 4.3 euros (95% CI: -0.9 to 9.4) for each patient on the study day and 48.9 euros (95% CI: -17.5 to 115.1) for total treatment for each patient. Figure 2 shows the difference of the observed costs from the costs that would have resulted from ID consultations. Some outliers were noticed which might explain the surprisingly lower-than-expected price differences. For example, the treatment at the extreme left on the medical ward of hospital A was due to the ID consultant's proposal to use a more expensive, broad-spectrum antibiotic to treat a polymicrobial infection which was considered inadequately covered by the agent actually used. Given the small numbers in each ward, this particular type of situation could almost balance out the savings obtained with other patients.

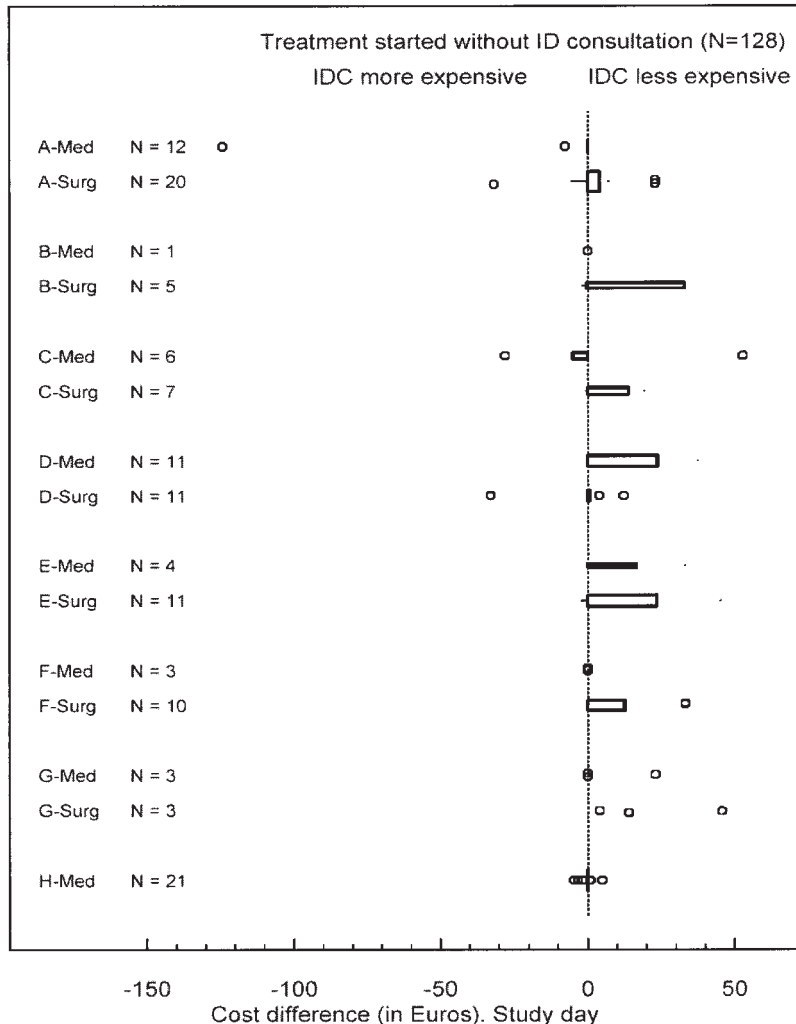
**Figure 1**

Relation of percentage of antibiotic (AB) misuses to percentage of AB prescribed without ID consultation, by hospital (A-H) and by ward.



**Figure 2**

Box-plot of the differences in the cost of antibiotics prescribed by internists and surgeons and those proposed by infectious disease consultants (IDC), by hospital and by ward (study day), for patients treated without ID consultation (n = 128).



## Discussion

This study confirms the high proportion of hospitalised patients who receive antibiotics. Previous publications have shown rates varying between 20 and 50%, which is higher overall than our findings (25%) [6–9]. This may be due to differences in the populations studied, since for the present exercise we excluded intensive care units and paediatric wards and included only non-university hospitals: it has been shown that more antibiotics are used in large tertiary-care teaching hospitals than in other settings [10]. Interestingly, the proportion of surgical patients on antibiotics (26%) did not differ significantly from that of medical patients (24%). The most frequent indications for antibiotics and the agents most frequently used were identical to those reported in other publications [8, 9].

Like Moss et al. [8], we found an overall rate of 47% antibiotic misuse, after excluding prescriptions secondary to an infectious disease consultation. Although this percentage reflects a large proportion of inadequate treatment or prophylaxis, it may result from errors of unequal clinical or economic importance. For example, administering a correct antibiotic for 2 days longer than usually recommended has surely less impact than exposing a patient to an unjustified treatment or an ineffective drug. We nevertheless found, like Dunagan et al. [11], that the most frequent reason for antibiotic misuse was the absence of an indication for such drugs, corresponding in our study to 13% of prescriptions without a prior ID consultation. Similarly, Wilkins et al. found that 7% of the inpatients they were seeing during ID consultations had been incorrectly diagnosed on admission and that 41% were given sub-optimal antibiotic treatment at the time of the consultation [12].

Our findings also confirmed observations by Moss et al., who reported a particularly high rate of antibiotic misuse in surgical prophylaxis, with only 5% of prescriptions fulfilling all the usual requirements and 22% fulfilling none of them [8]. Surgeons are particularly prone to disregard published guidelines for surgical prophylaxis, chiefly by keeping operated patients on antibiotics for unnecessarily long periods of time. These errors contributed substantially to the higher rates of antibiotic misuse our study found on surgical wards.

As illustrated in this study by the approx. 6,256 euros saving that would have been generated by state-of-the-art treatment and prophylaxis, the economic impact of the frequently inappropriate use of antibiotics is far from negligible, although the 95% CI is wide, including cost savings as well as increases. Savings could be boosted by taking into account indirect costs such as intravenous lines, excess workload or excessive length of hospital stays. Parret et al. demonstrated that the cost of the antibiotics used on the medical and surgical

wards of a university hospital could be cut by 3.5% if the recommendations of ID consultants are followed [6]. Pestotnik et al. observed a 25%–13% reduction in antibiotic expenditure after the introduction of computer-assisted prescriptions based on guidelines [7]. Fraser et al. showed that the implementation of guidelines could help to save \$400 for every antibiotic treatment prescribed [13]. Similar observations were also reported for surgical prophylaxis [14]. The need to obtain the ID consultant's authorisation before administering antibiotics generated a decrease from \$60,000 to \$16,000 in the yearly \$1.4 million allocated to antimicrobial agents at the Yale-New Haven Hospital [15].

The present study does not allow conclusions to be drawn regarding resistance to antibiotics. It is nevertheless well established that, besides their impact on costs, interventions aiming at controlling antibiotic use help to fight the emergence of resistant bacteria [1, 2, 4]. For example, avoiding prolonged surgical prophylaxis could lower the risk of nosocomial infections due to resistant organisms. Harbarth et al. found that patients who had received prophylactic antibiotics for more than 48 hours after cardiac surgery were as likely to suffer from a surgical site infection as those who had been on antibiotics for a shorter period, but were more likely to have positive cultures for resistant bacteria [16]. It has also been shown, as in Finland, that interruption of selection pressure by withdrawal of an antibiotic class is a means of reversing the resistance rates of bacteria to that class of antimicrobials [17].

Although there is a consensus in favour of a multidisciplinary approach for the control of antibiotic use by involving ID physicians, microbiologists, pharmacists and administrators, many different modes of intervention have been studied, including the implementation of locally developed guidelines, physician training, computer-assisted prescription, specialist's authorisation or the completion of written forms [18–21]. In each of these modes the participation of ID consultants appears to play an important role [21, 22].

Daily discussion with or systematic visits to the ID consultants, particularly in surgical wards, would probably save money.

This study has several limitations. Some are linked to its one-day prevalence survey design, which may have resulted in over- or underestimation of the usual rates of antibiotic use or misuse. But the fact that it took place in eight hospitals simultaneously should minimise these risks. In addition, the study included hospitals with ID consultants, which are still not the rule in Switzerland. Even though the quality of prescriptions secondary to their intervention was not assessed, their frequent interactions with other physicians may have had a "contagious" effect contributing to overall

better antibiotic use than in other Swiss hospitals. Moreover, comparisons between the participating hospitals should be treated with caution for two reasons: first, because some heterogeneity was found in the opinions of the ID consultants regarding similar clinical situations and, second, because each hospital had its own drug form including different antimicrobial agents. Lastly, the study did not look for patients who were not on antibiotics but who, in the experts' opinion, might have needed them.

Finally, this study confirmed, in the particular setting of medium-sized, non-university Swiss hospitals, others' findings regarding the high frequency of antibiotic misuse in hospitals. Assuming ID consultants always correctly apply antibiotic guidelines, we have shown that substantial improvements are possible in the use of antibiotics. In our opinion, such studies should be made

general, to heighten clinicians' awareness of the economic and epidemiological impact of antibiotic misuse and prompt them to find ways of fighting excess costs and the emergence of resistant bacteria, while improving the quality of care and their patients' safety.

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