Influence of an Infectious Disease Service on Antibiotic Prescription Behavior and Selection of Multiresistant Pathogens

S.W. Lemmen, H. Häfner, S. Kotterik, R. Lütticken, R. Töpper

Summary

Background: A routine infectious disease service was established in January 1998 in order to optimize the antibiotic usage and prescription pattern of a neurologic intensive care unit (NICU).

Methods: Treatment guidelines for the most prevalent infections were implemented and individual antibiotic regimes were discussed at the bedside with infectious disease experts.

Results: This interdisciplinary cooperation reduced the total number of antibiotics prescribed by 38.1%, from 7,789 in 1997 to 4,822 in 1998, without compromising patient outcomes (mortality rate: 22/313 patients in 1997 vs 32/328 patients in 1998). Total patient days (2,254 days vs 2,296 days) and average length of stay in the NICU (7.2 days vs 7.0 days) were comparable. Antimicrobial expenditure decreased by 44.8% (71,680 Euros in 1997 vs 39,567 Euros in 1998). Taking into account the costs for the infectious disease service (approximately 8,000 Euros in 1998), a total saving of 24,113 Euros was made. The dramatic reduction in antibiotic usage (mainly of carbapenems) resulted in a statistically significant decreased isolation of *Stenotrophomonas maltophilia* ($p < 0.05$), *Enterobacter cloacae* ($p < 0.05$), multiresistant *Pseudomonas aeruginosa* ($p < 0.05$) and *Candida* spp. ($p < 0.05$), without any change in the infection control guidelines.

Conclusion: These data show that an infectious disease service can optimize and reduce antibiotic usage. This results in a decrease in the occurence of multiresistant gram-negative pathogens and *Candida* spp. in intensive care units and, at the same time, saves costs.

Key Words

Infectious disease service · Cost control · Multiresistant pathogens · Intensive care · Antibiotics

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Introduction

Antibiotics are among the most expensive drugs used in hospitals [1]. In intensive care units (ICU), in particular, physicians tend to use broad-spectrum antibiotics indiscriminately [2]. The development of bacterial resistance to antibiotics correlates with antimicrobial use, and preventing resistance clearly requires optimization of antibiotic treatment [3–5]. Data from the project "Intensive Care Antimicrobial Resistance Epidemiology" (ICARE) illustrates that the majority of antimicrobial-resistant pathogen rates were highest in the ICU and lowest in the outpatient setting [6, 7].

Most countries worldwide have an infectious disease specialist assisting the clinicians in diagnosing and treating specific infections. This is especially important for infections in the ICUs, where the emergence of resistant bacteria has made treatment very difficult and even, in some cases, impossible [8]. Furthermore, early initiation of appropriate antimicrobial therapy is critically important for reducing mortality and morbidity among patients with bloodstream infections [9]. This requires knowledge of the likely pathogen(s) and the corresponding regional antimicrobial susceptibility patterns [10]. However, unjustified antibiotic treatment in patients without bacterial infection is associated with a higher lethality rate [11].

The present study was performed to evaluate the extent to which an infectious disease service can reduce costs and influence the emergence of multiresistant pathogens.

Methods

The neurological ICU (NICU) is an eight-bed facility at the Aachen University Hospital, which is a tertiary referral centre for a population of approximately 500,000 inhabitants in the Aachen

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Table 1
Patient characteristics and comparison of antibiotic usage.

	1997 without consulting service	1998 with consulting service	
No. of patients	313	328	ns
Patient days	2,254	2,296	ns
Medium length of stay in NICU (days)	7.2	7.0	ns
Death/year	22	32	ns
Antibiotic administrations/day	3.5	2.1	p < 0.05
Medium antibiotic cost/day (Euros)	31.6	17.0	p < 0.05

ns: not significant

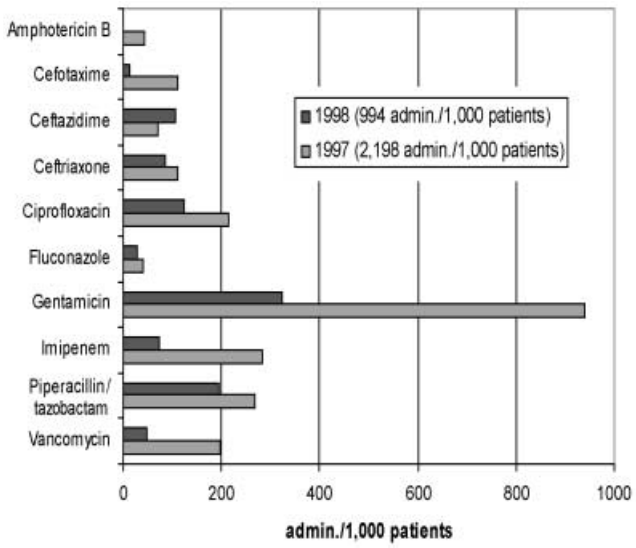

Figure 1
Comparison of antibiotic administration 1997/1998.

area. Patients in the NICU are mechanically ventilated in about 85% of cases. Approximately 95% of them have a central venous catheter, and all of them have a permanent urinary tract catheter. Treatment guidelines for the most common nosocomial infections were established by the authors in accordance with the recommendations of the national and international infectious disease societies. Current local antibiotic susceptibility patterns were taken into account for the most common pathogens.

A routine infectious disease service was established in January 1998. Once a week an infectious disease specialist and the physicians of the NICU met for a ward round. In addition, the infectious disease specialist was available for urgent consultations on an on-call basis. All patients were reviewed and for those receiving antibiotics the choice of antimicrobials as well as dosage and length of treatment were discussed. The workload of the infectious disease service was calculated at about 4 h per week; microbiologic data were analyzed using the Hybase on-line statistics program (K&L Konzepte, Witten, Germany). Only one bacterial isolate per patient was used for final microbiological analysis to avoid overrepresentation due to copy strains. Data about antimicrobials administered and their costs were provided by the university hospital central pharmacy. During the study period there was no change in infection control guidelines. Statistical analysis was performed using Fisher's exact test.

Results

No significant statistical differences were seen between 1997 and 1998 regarding total number of patients treated, patient days on the NICU, mean length of stay, or the number of death during stay on the NICU (Table 1). Overall administration of defined daily doses of antimicrobials declined by 38%, from 7,789 (1997) to 4,822 (1998) representing a cost reduction of 32,113 Euros (71,680 Euros in 1997 vs 39,567 Euros in 1998; 44.8%). This difference has been adjusted for a decrease in costs of antibiotics between 1997 and 1998. There was a slight increase in the use of penicillin, flucloxacillin, ampicillin, 2nd generation cephalosporins, macrolides and clindamycin but a marked decrease of 54.8% in the administration of carbapenems, quinolones, 3rd generation cephalosporins, glycopeptides, aminoglycosides, and piperacillin/ tazobactam (Figure 1). The cost of maintaining the infectious disease service was approximately 8,000 Euros for the 12-month intervention period, based on the average salary of an infectious disease consultant.

Table 2 shows the difference in distribution of patients colonized or infected with multiresistant gram-negative pathogens or *Candida* spp., for the periods with and without an infectious disease service. Overall, isolation of *Pseudomonas aeruginosa* increased in 1998, but multiresistant strains were isolated less frequently. Other species such as *Acinetobacter* spp., *Serratia* spp., methicillin-resistant

Table 2
Comparison of number of patients with multiresistant pathogens or *Candida* spp.

	1997 without consulting service	1998 with consulting service	
Stenotrophomonas maltophilia	15	5	p < 0.05
Enterobacter spp.	66	39	p < 0.05
Pseudomonas aeruginosa	17	31	p < 0.05
Imipenem resistant	3/17 (18%)	1/31 (3%)	ns
Tobramycin resistant	2/17 (12%)	1/31 (3%)	ns
Piperacillin of tazobactam resistant	1/17 (7%)	0/31 (0%)	ns
Candida spp.	77	44	p < 0.05

ns: not significant

Staphylococcus aureus or vancomycin-resistant *Enterococcus* spp. are not shown, due to the low number of strains isolated.

Discussion

A number of guidelines for the rational use of antibiotics has been developed [12–18], but limited data are available concerning the effects of such approaches on cost savings, patient outcome and the long-term effect on drug resistance [19, 20]. The inception, distribution and implementation of an antibiotic policy is costly and thus must demonstrate its impact on cost and quality of prescribing [21]. Despite reports in the literature, it is still a matter of debate whether excessive and inappropriate use of antibiotics can be controlled by implementing guidelines, restrictive formularies or educational effort without providing regular consultant service [22]. To address this problem, information about an individual patient must be provided at the bedside by an infectious disease expert to assist the clinician in deciding whether to use an antibiotic [22].

The results of this study show that written treatment guidelines for nosocomial infections, combined with a bedside infectious disease consulting service, resulted in a reduction in antibiotic administration. Antimicrobial expenditure could be reduced by 44.8% (32,113 Euros) without compromising patient outcome or length of stay in the ICU. Considering the costs of the infectious disease service (approximately 8,000 Euros) during the study period, the implementation of this service was extremely cost-effective, saving a total of 24.113 Euros. In addition, it contributed to an overall reduction in problematic and multiresistant pathogens, with a significant decrease in isolation of *Enterobacter* spp. and *Candida* spp., without any change in the infection control guidelines concerning the isolation procedures for patients being colonized or infected with multiresistant bacteria.

Implementing an antimicrobial control program requiring prior approval for selected parenteral agents from the infectious disease department decreased total parenteral antimicrobial expenditure by 32% [19]. During the same study period susceptibilities to all β-lactam and quinolone antibiotics increased in isolates from the ICU and other inpatient sites, despite unchanged infection control guidelines. *Coleman* et al. [13] assessed the impact of a parenteral antibiotic control policy and an infectious disease service which reviewed the appropriateness of antimicrobial therapy on cost and patient outcome. Their efforts resulted in a yearly antibiotic cost reduction of 32%. In subpopulations such as patients with respiratory tract infections, reductions were as high as 45%. It is well-documented that considerable expenditure for antimicrobials is related to unjustified usage. Empiric selection of antibiotics in the treatment of bacteremia was evaluated as inappropriate in 35% of cases [23]. Inadequate duration of treatment in 22% of cases resulted in additional hospital expenditure of up to USD 28,000 per patient [24].

The marked reduction in isolation of *Stenotrophomonas maltophilia* was associated with a 75% reduction of carbapenem usage in 1998; *Sanyal* et al. [25] reported a correlation between carbapenem usage and the emergence of *S. maltophilia* in specialized hospital units in Kuwait. The reduction of multiresistant *P. aeruginosa* strains did not reach statistical significance due to low numbers but reflected the trend seen with other multiresistant bacteria.

In conclusion, the reduction of antimicrobial administration and the resulting cost saving reported in this study confirm the need for an infectious disease service at the bedside. The net cost reduction suggests that an infectious disease service is highly cost-effective and, in addition, contributes to an overall reduction of multiresistant pathogens.

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