Pharmaceutical care: pharmacy involvement in prescribing in an acute-care hospital

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Abstract
Backgrouind: Pharmaceutical care implies reaching a consensus with physicians on prescriptions in cases that call for the substitution of one active ingredient for another, a modification in dose, frequency, route of administration, etc., through the unit-dose distribution system. The goal of pharmacist interventions in the hospital should be to achieve a rational use of drugs; to ensure this, a daily review of patient prescriptions by a pharmacist is necessary. Most of the incidence of drug-related morbidity and mortality is predictable and can be avoided, thus reducing the overall cost of health care and the duration of hospitalization while improving the quality of care. The optimum quality of physician or pharmacist care to be achieved would be one that which maximizes benefits and minimizes risks and costs.
Objective: The goal of this study was to evaluate pharmacist interventions at the Hospital of Barcelona over a six-month period and their clinical and economic repercussions and the degree of compliance.
Method: The interventions were recorded on a card and classified by type: antibiotic or thromboembolic prophylaxis; substitution of an active principle not included in the hospital's Pharmacotherapeutic Guide; change in dose or route of administration; therapeutic duplication; dose adjustment of aminoglycosides and vancomycin; and inappropriate treatment duration. The economic evaluation considered the average cost of a hospital stay and of the procedures and diagnostics in 1998 and applied data on published probability rates and drug costs.
Results: A total of 3,136 interventions were analyzed prospectively during the study period. The interventions represented savings of 129,058.31 euros. Those that contributed most to these savings were recommendations for antibiotic prophylaxis, thromboembolic prophylaxis and pharmacokinetics studies: 49.4, 47 and 5.7% of interventions, respectively, and 79, 3.6 and 15% of total savings, respectively.
Conclusion: In general, the degree of acceptance of the interventions was high (88.8%), as a result of the growing compliance by physicians with the hospital's established protocols. It can be concluded that pharmacist interventions have been useful to improve patient care and have been important to help educate physicians on the quality of drug therapy.

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Introduction

Pharmaceutical care, implies communicating and reaching a consensus with physicians about prescription incidences detected such as the substitution of one active principle for another or the modification of dose, frequency, route of administration, etc., through the unit-dose drug distribution system (UDDS). To do this, the pharmacist participates actively and in coordination with other health-care professionals, with a positive influence in patient quality of life.

The current tendency in developed countries is to improve the quality of services provided by increasing the efficiency of processes and evaluating the results obtained. To do this, it is necessary to monitor not just the starting point of a treatment, but the entire course, and to have the opportunity to modify the treatment in consonance with the patient's response, thereby improving results[1–5].

The optimum quality of pharmaceutical or medical care to be achieved would be that which maximizes profits and minimizes risks and costs[6–9]. The Pharmacy Service has quality control systems in place covering all activities carried out[10].

Pharmacist interventions in the hospital environment should aim to achieve a rational use of drugs; to do this, a daily review of patient prescriptions by a pharmacist is necessary[11–13].

An inappropriate (overlong) duration of antibiotic treatment can lead to an increase in morbidity and, therefore, an increase in the costs associated with treating the patient[14].

The pharmacist's activities include the identification and solution of problems related to drugs, and also to prevent these problems from occurring.
The clinical and economic evaluation of the outcome of pharmaceutical care to patients has been described by several authors[15,16]. In 1999 Mutnick et al.[15] presented the results of 4,648 pharmacist interventions made by 50 members of the pharmacy staff of a university hospital to evaluate patient pathologies and the appropriateness of the drug therapy selected. They assigned a code to each for the potential severity of the consequences if the clinical intervention could not be made and they analyzed the cost savings. Of these interventions, 87% were accepted by the medical staff. The accepted interventions represented a net therapy cost savings of $487,833 and $158,563 achieved by prevention of a potential net 371.9 additional hospital days. In another study [16], Weidle analyzed 68,177 pharmacist interventions and presented results showing a total cost savings of $1,588,061 ($23.54/pharmacist intervention).

Drug-related morbidity and mortality can often be prevented, and pharmacy services can reduce the number of adverse drug events (ADEs), the length of hospital stay, and the cost of care[1]. Most of the incidences of drug-related morbidity and mortality is predictable and preventing these would reduce the overall cost of health care and the duration of hospitalization while improving the quality of care[17,18].

Classen et al.[19] calculated in the excess length of stay (1.74 days), extra costs ($2,262) and mortality

attributable to adverse drug events in hospitalized patients.

Another important aspect of pharmacist interventions in hospitals is in the control of infections. It has been shown[20] that prophylactic antibiotics administered at the optimum moment reduce the infection rate of surgical wounds from 3.3% to 0.6%.

In order to evaluate the importance of pharmacist interventions for both patient care and economically, and to improve rates of drug and prescription errors, etc., it is necessary to record and evaluate the pharmacist interventions that occur. Therefore, the purpose of our study was:

- To record and study the interventions (to detect and correct possible errors in the drugs prescribed regarding dose, frequency, treatment duration, etc.).
- To ensure that prescriptions are in accordance with the Pharmacotherapeutic Guide.
- To evaluate the degree of compliance with the changes proposed for prescriptions and with the hospital's established protocols.

Thus, we were able to evaluate the repercussions of the pharmacist interventions that are done on a routine, daily basis in the Pharmacy Service, regarding both patient care and an economic point of view.

Method

General characteristics of the hospital and the Pharmacy Service

The Hospital de Barcelona is a 330-bed acute-care hospital. In 1998 the hospital registered 21,109 admissions, 13,585 surgical operations and 2,087 births with an average stay of 4.62 days. The hospital works with diagnosis-related group (DRG) cost data and the International Classification of Diseases, 9th Revision Clinical Modification (ICD9CM). Currently, 94% of the medications consumed are billable by patient. Activity in 1998 comprised 191,988 medical orders processed (in 1999, 58% of medical orders were entered in the computer directly by physicians), 1,841,516 drug units dispensed, 2,236 cytostatic preparations, 1,455 parenteral nutrition preparations, 11.503 intravenous admixtures and formulas, 659 drug patients information and 277 pharmacokinetics reports.

Material

Records of the pharmacist interventions (Appendix) during the study period. The Pharmacist Intervention Record was designed for use in the evaluation on the basis of published information[15]. This record has two parts: the first part contains identification data (patient, diagnosis, drug) and the degree of acceptance of the pharmacist interventions, and a second part including other types of data such as the type of intervention, calculations, etc.

Methodology

A multidisciplinary team comprising two pharmacy interns, seven pharmacists, one physician from Internal Medicine, and an economist analyzed, prospectively, all pharmacist interventions from September 1, 1998, to February 28, 1999. Direct consultations by physicians and/or nurses with the pharmacists were not counted as interventions, whether done in person or by telephone, nor were clarifications of prescriptions.

The method for calculating the cost of the interventions was based on the articles by Mutnick[15] and Weidle et al.[16].

For calculating the cost of the intervention, bearing in mind the average cost (1998) of the hospitalization, procedures and diagnostics avoided by pharmacist intervention and applying published probability data. Neither the time spent on each intervention nor the time spent in evaluating interventions was calculated into the cost. This section is explained in detail for each type of intervention.

The severity levels of risk avoided were analyzed according to Mutnick's classification[15]:

- *Unimportant.* Has no direct effect on patient's clinical situation (e.g., changing to a treatment that was less expensive but equally effective);
- *Significant.* May influence patient's clinical situation. This would be the case of a reduction in days of treatment, the avoidance of unnecessary injections or the avoidance of unnecessary drug combinations;
- *Serious.* Affects patient's clinical situation. Avoids potential slight adverse reactions, incorrect dosages (under or over), incorrect antibiotics combinations (synergy of adverse events), postoperative infection and/or thromboembolism; and
- *Fatal.* Can directly affect patient's life. Avoids serious adverse events, toxic dosings of drugs with a narrow therapeutic margin.

They were very specific interventions that were difficult to classify and were not evaluated economically. The pharmacist interventions were classified by the type of incidence detected in the type of incidence detected in the prescription.

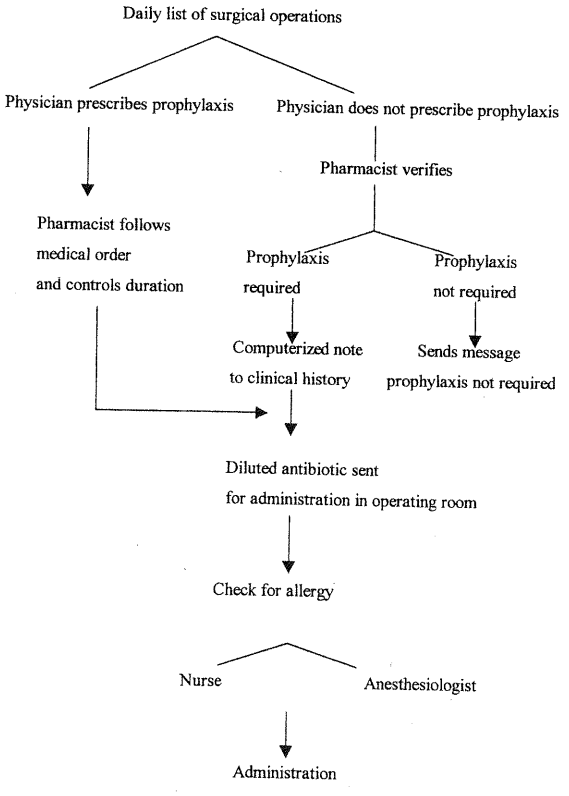


Figure 1 *Route for establishment of surgical antibiotic prophylaxis.*

- postoperative analgesia with opiates (such as petidine) for more than four days, except cases such as terminally ill patients, cancer patients, patients with cardiopathies, etc.;
- empirical treatment with antibiotics for a period of more than seven days.

The number of units of medication not administered and the cost per unit were used for the calculation of the savings generated by this type of intervention.

Non-formulary prescription

In the Hospital de Barcelona, drugs are chosen by the Pharmacy and Therapeutics Committee and described in the Pharmacotherapeutic Guide, which includes the drugs available from the Pharmacy Service (published and accessible from all hospital computer terminals; updated annually). The savings generated as a result of this pharmacist intervention are calculated by the difference between the cost of obtaining a drug urgently, usually from a wholesaler, and the cost of the formulary drug.

Alternative therapy

When a physician prescribes a drug that is not included in the hospital Pharmacotherapeutic Guide, the pharmacist substitutes it with a similar drug that is included in the Guide and that is from the same therapeutic class. The savings incurred by the difference between the costs of the two treatments in this type of pharmacist intervention.

Pharmacokinetics

In the Pharmacy Service of the Hospital de Barcelona, patients treated with aminoglycosides (amikacin and gentamicin) and/or vancomycin have the dosages routinely adjusted on the basis of pharmacokinetics criteria[24]. Figure 2 shows the route of pharmacist intervention and pharmacokinetics follow-up of these patients. We consider as pharmacist interventions or patient monitoring all patients treated for less than three days who have undergone a dosage adjustment.

We reviewed the clinical histories of the following patients to observe if renal function deteriorated or improved:

- non-monitored patients with a treatment period longer than 10 days;
- patients being treated with aminoglycosides and vancomycin;
- monitored patients, but with a treatment duration of more than 20 days.

The calculations of the savings resulting from the pharmacokinetics intervention are based on a probability of 5% that nephrotoxicity will appear in cases of monotherapy[1,2] and a probability of 22% in cases of combination therapy of an aminoglycoside and vancomycin[2], multiplied by the cost of hospitalization and the average number of days of hospitalization due to acute renal insufficiency and adding or subtracting from this value the difference in the cost of the medication units administered with respect to those prescribed by the physician.

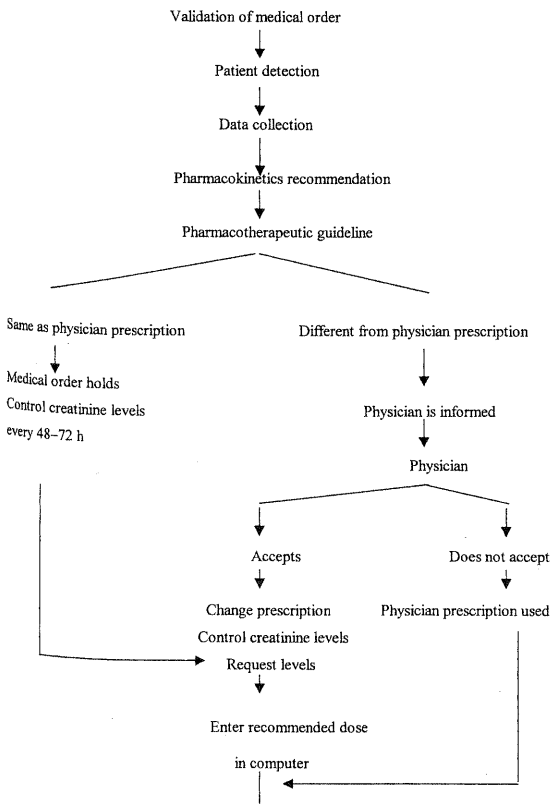


Figure 2 *Route for pharmacokinetics follow-up of patients.*

Thromboembolic prophylaxis

Venous thromboembolic disease is a problem owing to its high incidence in certain patient groups, the difficulty of detecting it clinically and owing to the morbidity and mortality of pulmonary thromboembolism (PTE) and of post-thrombotic syndrome, which are the principal complications of deep vein thrombosis (DVT)[1]. The application of prophylactic measures reduces the morbidity and mortality of thromboembolic disease in hospitalized patients as shown in Table 3.

The Pharmacy Committee developed a series of recommendations for the prophylaxis of postoperative thromboembolic disease utilizing heparin, and disseminated these recommendations among all physicians attending our hospital. These recommendations indicate, by type of operation, the most suitable type of prophylaxis and when it should be applied[25,26].

The pharmacists detect preoperatively patients who should receive thromboembolic prophylaxis by consulting the operating room schedules and considering the type of surgery, patient's age, and whether or not the physician has prescribed the corresponding peroperative prophylaxis. If this has not been prescribed, the pharmacist makes a note in the clinical history and, depending on patient characteristics and the type of operation, suggests the administration of thromboembolic prophylaxis to reduce the risk of postoperative complications.

Dose, form, route and frequency

Validation of the prescription by the pharmacist frequently means rationalizing a correction of the dose, form, or route or frequency of administration. The calculation of the savings obtained by the pharmacist intervention was done by deducting the cost of the medication administered from that of the medication originally prescribed.

Surgical antibiotic prophylaxis

Nosocomial postoperative infection is one of the most important causes of hospital morbidity and mortality. On the basis of the computerized schedule for operations, the Pharmacy Service sends the antibiotic recommended by the surgical procedures. The surgical procedures selected for inclusion in this study were those included in the Surgical Antibiotic Prophylaxis protocol of the Hospital de Barcelona[21]. Figure 1 shows the route of this pharmacist intervention. The calculations of cost savings incurred with the pharmacist intervention were done by multiplying the cost per day of hospitalization by the average number of days of hospitalization caused by an infected wound for each procedure in our hospital according to the DRG and then by the probability that this infection would have occurred had prophylaxis been administered. The cost of the antibiotic is subtracted from this total.

Table 1 *Risk of infection (%) by type of surgery* [21]

Type of surgery	*Without antibiotic prophylaxis*	*With antibiotic prophylaxis*
Clean	5.1	0.8
Clean-contaminated	10.1	1.3
Contaminated	21.9	10.2
Dirty	–	–

The probability of surgical wound infection used in these calculations depends on the type of surgical procedure performed, which can be classified as follows: clean, clean-contaminated, contaminated and dirty[20]; probabilities are shown in Table 1. The probability also depends on the antibiotic's being administered at the correct time. The probability of infection if prophylaxis timing is correct is 0.6%[20].

Because few studies have been done, it is difficult to determine the average number of days of hospitalization caused by surgical wound infection in each specific procedure. One publication[22] on specific surgical procedures, all with antibiotic prophylaxis, differentiates between days of hospitalization for infected patients versus uninfected patients.

The increase in the number of days of hospitalization for surgical wound infection used to calculate the cost of the pharmacist interventions was obtained from three different sources: in seven surgical procedures, from the above-mentioned publication[22]; in two procedures, from the Hospital de Barcelona's own data[23]; and in the remaining cases, where no literature reports were found, on the basis of the generally accepted principle (GAP) that a surgical wound infection doubles the normal number of days of hospitalization for a procedure (Table 2).

Inappropriate duration

During the validation of medical orders, the pharmacist can evaluate if the duration of a prescription appears to be excessive, such as in the following cases:

Table 2 *Increase in days of hospitalization due to surgical wound infection*

Procedure	*Mean days hospitalization Hospital de Barcelona*	*Increase in days hospitalization publication (n)*	*Increase in days hospitalization Hospital de Barcelona (n)*	*Increase in days hospitalization according to GAP*
Cholecystectomy	3.3	10.0 (197)		
Herniorrhaphy	4.8	11.0 (194)		
Aortocoronary bypass	18.2		14.8 (2)	
Total hip prosthesis	10.7			10.7
Total knee prosthesis	10.8			10.8
Acromioplasty	2.8			2.8
Osteosynthesis	6.7			6.7
Hallux valgus	3.5			3.5
Vaginal hysterectomy	5.3	3.0 (31)		
Mastectomy + lymphadenectomy	6.0			6.0
Craniotomy	13.0			13.0
Exploratory laparotomy	10.5	10.0 (202)		
Appendectomy	4.7	6.0 (186)		
Hemorrhoidectomy	1.6			1.6
Osteotomy	3.2			3.2
Hemicolectomy	13.9	5.0 (610)		
TUR prostate	5.6			5.6
Radical prostatectomy	7.9		1.3 (2)	
Ligamentoplasty	3.8			3.8
Resection	1.1			1.1
TUR bladder	4.1			4.1
Rectocele	4.8			4.8
Abdominal hysterectomy	6.2	3.0 (46)		

GAP – generally accepted principle; n – number of cases infected; TUR – transurethral resection.

Table 5 *Percent ajusted dose of patients receiving aminoglycosides and vancomycin in which pharmacy (179 interventions)*

Pharmacokinetics	1998			1999		
	Sept	Oct	Nov	Dec	Jan	Feb
Patients with pharmacist intervention	87.0	78.0	80.5	81.3	78.6	87.8
– Individual pharmacokinetics study	(32.2)	(24.4)	(9.8)	(21.9)	(25.0)	(33.3)
– Dose adjustment	(54.8)	(53.6)	(70.7)	(59.4)	(53.6)	(54.5)
Patients without pharmacist intervention	13.0	22.0	19.5	18.7	21.4	12.2

ommended dosage could have reached or did reach toxic concentrations in serum. There were four cases where the dosage prescribed was infratherapeutic.

Thromboembolic prophylaxis

The cost of this intervention is obtained with the equation (E × F × G × H) + drug cost, where,

E = average days of hospitalization for thromboembolic complications = 6.6 days,

F = average cost/day of hospitalization = 268.3 euros

G= probability that having administered a low-molecular-weight heparin as prophylaxis, mortality due to postoperative complications will be reduced = 25%,

H= increase in probability of postoperative complications if heparin is not administered = 16% in general surgery and 38% in orthopedic surgery.

Of the 47 thromboembolic interventions, 36 were recommendations to start thromboembolic prophylaxis with heparin and the rest (11) were for a change in dosage (from heparin 2500 IU to heparin 5000 IU).

Non-formulary prescription

Five interventions were not accepted; two of these were justified.

Inappropriate duration

Interventions recommending suspension of treatment owing to inappropriate duration were accepted in 234 cases, 93 of which were because the patient was released. The recommendation was not accepted in 96 cases, in 46 of which this was justified.

Others interventions

The 14 interventions regarding dosage, form, route and frequency generated a savings of 370.29 euros.

Discussion

Antibiotic prophylaxis

The frequent pharmacist intervention was due to the large number of operations performed at our hospital. The percentage of compliance in this type of intervention was 83.5%, higher than the rate of 51.1% obtained by Delgado et al.[27]. Our results therefore show a high level of suitability of the timing to the recommendations of Classen et al.[20].

Of the 852 operations that did not require prophylaxis, in 15% once the surgeon was in the operating room he or she deemed it appropriate to administer an antibiotic.

The months with the greatest number of prophylactic interventions were the hospital's busiest months. The surgical procedures most used were those for General and Digestive Surgery and for Orthopedics and Traumatology. These therefore correspond to the prophylactic interventions that have generated the greatest savings.

In general, the severity of the interventions of surgical antibiotic prophylaxis was serious because they involved the prevention of a potential surgical wound infection. The result for the patient was, in most cases, an effective therapy.

Pharmacokinetics

With regard to the degree of severity, the interventions were serious because we avoided potential cases of renal insufficiency, some of which could have been fatal. With regard to patient outcome, in each case where pharmacokinetics was monitored, the patient's renal function improved. In cases where there was no monitoring despite a recommendation to do so and where the renal function subsequently deteriorated, another antibiotic was substituted after consultation with the physician.

The data obtained in this regard (82.2%) were superior to those obtained in a study of quality control analysis of aminoglycoside management in which only 53.1% of aminoglycoside treatments were adjusted[28]. Another study that identified patients treated with aminoglycosides reported that of 154 patients, only 31.8% required a dose adjustment[29]. Pharmacokinetics interventions generated the second most important savings of all the interventions evaluated. They were third in terms of number.

Thromboembolic prophylaxis

We observed that the number of interventions of this nature decreased considerably with respect to the previous pilot study. Our explanation is that the pilot study was done shortly after the implementation of corrective measures and efforts to impress upon the physicians the need for prophylaxis and the risk of complications. This is reflected in the degree of compliance with the protocol for thromboembolic prophylaxis in recent years in a statistically representative sampling of 495 interventions (in 1996, 68%; in 1997, 80%; in 1998, 85%). This was the intervention that generated the third largest savings of all the interventions; it was, however, low in terms of number of interventions. The rate of compliance with the recommendation was higher than that found in a similar study, which reported a rate of 78.4%[30].

Table 3 *Average incidence of postoperative thromboembolic disease*[25]

Group at risk	DVT (%)		PTE (%)	
	Without prophylaxis	With prophylaxis	Without prophylaxis	With prophylaxis
General surgery	25	9	0.9	0.2
Orthopedic surgery	50	12	3	0.5

DVT – deep vein thrombosis; PTE – pulmonary thromboembolism.

Therapeutic duplication

The prescription of two equivalent medications has occasionally been detected by the pharmacist, such as:

- two nonsteroidal antiinflammatory drugs (NSAIDs);
- a prescription for antibiotic prophylaxis when the patient is already being treated with antibiotics; or
- two antiulcer agents, such as ranitidine and omeprazole or pantoprazole.

The calculation of the savings obtained by this pharmacist intervention is the cost of the units of medicine not administered as a result of the pharmacist's action.

Results

Table 4 shows the economic outcome and the degree of acceptance of all the pharmacist interventions performed.

Antibiotic prophylaxis

This was the most frequent pharmacist intervention (76.6% of the total). This type of intervention also generated the most savings (101,910.76 euros; 1 euro = 166,386 pesetas). The probability of infection used to calculate the cost of the pharmacist intervention according to the type of surgery into which an individual procedure is classified (Table 1) is:

Clean: $(5.1 - 0.8) \times 0.6 = 2.6\% \Rightarrow 0.026$

Clean contaminated: $(10.1 - 1.3) \times 0.6 = 5.3\% \Rightarrow 0.053$

Contaminated: $(21.9 - 10.2) \times 0.6 = 7.0\% \Rightarrow 0.070$

In 15% of the cases where a prophylactic antibiotic had not been sent to the operating room (theoretically not recommended), the physician had ultimately decided to administer antibiotic prophylaxis.

Considering that 90% of all antibiotics for prophylactic use are cefazolines, the cost of the intervention was based on the savings of one unit of this antibiotic for each pharmacist intervention where antibiotic prophylaxis was not prescribed.

Pharmacokinetics

Table 5 shows the adjusted dose percent age of patients receiving aminoglycosides and vancomycin. The cost of this intervention is obtained with the equation $(A \times B \times C) + D$, where:

A = % (probability of causing nephrotoxicity) = 5%,

B = cost/day of hospitalization = 268.3 euros,

C = average days of hospitalization due to acute renal insufficiency = 9.9 days

D = cost of drug that would have been used had there been no dose adjustment, less the cost of drug used according to the new prescription (this value can be positive or negative).

In those cases where the pharmacokinetics recommendation was not accepted (46 patients), in 18 patients the duration of treatment was less than 3 days, and in the other 28 cases, it was more than 3 days but less than 21. Of these 28 cases, in 3 the non-acceptance was justified and in another 3 cases there was a worsening of renal function.

There were 16 cases where, although the duration of treatment was less than 3 days, a recommendation was made and accepted; in 13 of those cases the rec-

Table 4 *Economic outcome and degree of acceptance obtained from the evaluation of 3,136 pharmacist interventions from September 1, 1998, to February 28, 1999*

Type of intervention	Interventions (n)	(%)	Acceptance (%)	Economic outcome (euros)
Antibiotic prophylaxis				
– Pharmacy prescription	1,549	49.4	87	101,141.69
– Not needed	852	27.2	85	769.07
Pharmacokinetics	179	5.7	75	19,343.86
Thromboembolic prophylaxis	47	1.5	85	4,619.09
Non-formulary prescription	137	4.4	96	1,550.36
Inappropriate duration	330	10.5	71	950.88
Dose, form, route, frequency	14	0.4	100	370.29
Alternative therapy	20	0.6	100	288.3
Therapeutic duplication	8	0.3	100	24.77
Total	3,136	100		129,058.31

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Non-formulary prescription

Patient outcome in this type of intervention did not involve an improvement in clinical status and, with regard to the level of severity, it was not important. The degree of acceptance of recommendations for substitution of non-formulary drugs (96%) was found to be higher than in other studies: in one it was 78.08%[31], in an other it was 81%[32].

The hospital unit or floor with the highest number of interventions was Traumatology, where patients who entered the hospital brought along medications that they habitually took at home and which were prescribed while they were in the hospital.

The substitution of non-formulary medications by formulary medications was the intervention that generated the fourth highest savings.

Inappropriate duration

Inappropriate durations were the second in number of interventions, but the savings generated by this type of intervention were the fifth highest. Treatment suspension was accepted either because the patient was released or because the physician reduced the length of treatment. In cases where the recommendation to shorten the treatment period was not accepted, non-acceptance was justified by patient pathology.

The distribution of interventions by hospital units or floors showed that the highest number of interventions corresponded to the hospital units that prescribed the most antibiotics. For most patients, the result of this was the administration of unnecessary drug doses and, in certain cases, additional days of hospitalization.

The level of severity for this group of interventions was generally significant and in some cases serious.

Alternative therapy

There were so few interventions recommending that a drug be switched to another drug of similar efficacy because there were a great number of substitutions during the evaluation period. With regard to patient outcome, this was an intervention that did not improve clinical status. They were not important interventions in terms of level of severity.

Regarding patient outcome, these interventions affected the efficacy of the therapy and had a serious level of severity, owing in some cases to the avoidance of doses that were not therapeutically effective or in other cases to the avoidance of overdoses.

One limitation of the study was the dependence on the copies of the pharmacists' interventions. A large number of interventions were resolved verbally rather than in writing and thus could not be recorded or evaluated.

One of the most important problems that we encountered when evaluating acceptance of the recommendations was the need to differentiate cases where non-acceptance was or was not justified. The opinion of the specialist in Internal Medicine was therefore of great help when reviewing the clinical histories. In some cases, when the pharmacist had recommended shortening the treatment duration, the specialist in Internal Medicine was in agreement with the physician regarding length of treatment.

The high degree of acceptance of the pharmacist interventions was because the physicians use the Pharmacotherapeutic Guide that is distributed to physicians and hospital units on an ever-increasing level and, furthermore, the information system does not allow direct prescription of drugs that are not included in the hospital's Pharmacotherapeutic Guide. Moreover, great importance is given in educational and informational sessions to the need to comply with the hospital's established protocols.

Conclusions

The 3,136 interventions carried out and studied represent a cost savings of e129,058.31 in the period between September 1998 and February 1999, inclusive.

Antibiotic and thromboembolic prophylaxis and pharmacokinetics were the largest contributors in terms of economic importance.

The degree of acceptance of the interventions by physicians was high: 88.8%.

In most cases, the result in the patient was an effective therapy and the degree of severity avoided was in general, significant or serious. In some cases of drug monitoring or prevention of thromboembolism, the degree of severity could have been fatal.

In the area of antibiotic prophylaxis, 87% of recommendations were accepted and in most cases the choice of antibiotic was correct.

Average acceptance of the recommendation to adjust the dose for patients being treated with aminoglycosides and vancomycin was 82.2%.

The implementation of corrective and educational measures in the area of thromboembolic prophylaxis in recent years has been found to be effective, with an increase in protocol compliance from 68% to 85% having been obtained in the last 3 years, especially in groups at risk.

Seventy-one percent of the recommendations regarding inappropriate duration of treatment were accepted.

With regard to non-formulary prescriptions, 96% of drugs prescribed were in the Pharmacotherapeutic Guide.

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